driving in wedges or keys at the end of the roll, which keys should be securely retained from moving by shrinking wrought iron collars on the shaft or axles; the working journals are turned in the wrought-iron shafts, after keying on the rolls, and the surfaces of the rolls turned; by which means of manufacturing rolls for rolling iron and other metals, the inventor is enabled to obtain them with stronger necks or axles. The wrought-iron shafts or axles are passed through hollow rolls, which the inventor prefers to be cylindrical openings in the cast iron rollers, but he does not confine himself thereunto, as other shapes may be used. The claim is for the manufacture of hollow cast rolls for rolling iron and other metals, and fixing thereunto wrought-iron shafts or axles, as described.

GAS METERS.

ALEXANDER ANGUS CROLL, of Suffolk-street, Clerkenwell, for "*Improvements in gas-meters.*"—Granted May 13; Enrolled November 13, 1846.*

The improvements relate to the use of a tumbler apparatus for actuating the valves of dry-gas meters with one partition, which approaches to and recedes from the plane of attachment to the side of the meter, but does not pass through the same; so that the flexible material whereof the diaphragm is partly formed, is bent only in one direction. The improvements consist in the application of an apparatus for working the valve, which depends for its action upon the use of a tumbler, so formed, that on being moved to a point just beyond the horizontal or central position, the tumbler will fall over and instantly change the position of the valve.

Fig. 1, Plate VI. is a vertical section of the improved meter; fig. 2, a vertical section, taken at right angles to fig. 1; fig. 3, is a horizontal section, taken on the line A, B, of figs. 1 and 2; and fig. 4, is a plan, top plate removed; *a*, the central part of the diaphragm, formed of metal, and *b*, the flexible material, fastened to the edge of the part *a*, and to the side of the meter at *c*, *c*; the part *a*, is so large that it cannot pass beyond the point *c*, where the outer edge of the flexible material is secured, but simply advances to and recedes therefrom; hence the bending of the flexible material will only be upon one surface. The diaphragm is supported in a vertical position by the frame *d*, *d*, which is jointed to it, and to the upright rod *e*, supported by the arm *f*, which is fixed on the vertical spindle *g*; the diaphragm is guided in its movements by the rods *h*, *h*, the lower ends of which are connected by short links to the part *a*, and their upper ends are suspended by a horizontal rod *i*, (inserted through them), from two arms *j*, *j*, fixed to the upper side of the cylindrical portion of the meter. Upon the top of the spindle *g*, is fixed an arm *k*, carrying a roller, which, being moved to and fro within the inverted arch *l*, on the tumbler tube *m*, will cause either end of that tube, alternately, to be raised from a depressed position to a point beyond the horizontal, when the weight, preponderating at the other end, will occasion the instanstaneous descent of that end, and this movement is communicated to the valve by the means hereinafter described;—the tumbler-tube falls on a spring *n*, at either side, and thus any shock is prevented. The tumbler-tube contains quicksilver, but shot may be substituted, and the tumbler apparatus may be otherwise varied, and yet retain the same character of action.

o, is an arm, fixed to the tumbler, and provided with a fork *p*, which acts on a plate or arm *q*, on the axis of the valve *r*, and by this means the position of the valve is changed at each movement of the tumbler, which, as will be readily understood, derives its motion from the reciprocating action of the diaphragm, communicated to it through the agency of the parts *d*, *e*, *f*, *g*, *k*, and *l*. The valve *r*, is contained in a valve-chest *s*, (to prevent the gas from coming into contact with the works in the upper part of the meter) into which the gas enters from the supply pipe through the passages *t*, *u*; by the movement of the valve, the gas is alternately admitted on either side of the diaphragm, and, after acting upon it, proceeds through the passages *v*, *w*, to the pipe leading to the burners. The motions of the diaphragm are registered by means of a detent or driver *x*, on the upper part of the spindle *g*, taking into a ratchet-wheel *y*, connected with an ordinary registering apparatus or index.

* The description of this patent was accidentally omitted in last month's Journal; the engravings are there given.

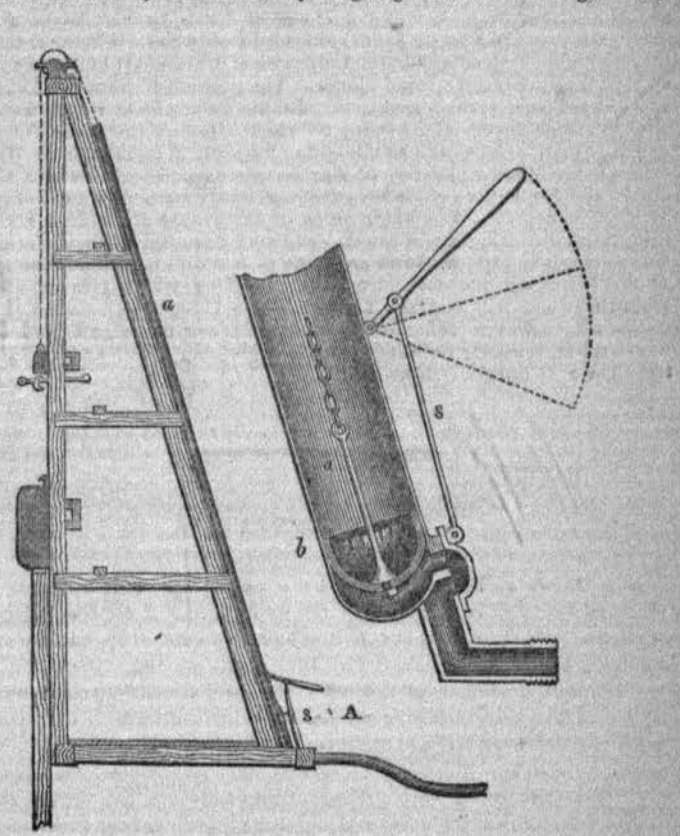
IMPERMEABLE SOLUTION FOR STONE.

FRANÇOIS TEYCHENNE, of Red Cross Square, Cripplegate, feather merchant, for "*Improvements in treating stone, to render it hard and impermeable, and in colouring the same.*" (A communication.)—Granted Aug. 6, 1846; Enrolled February 6, 1847.

The improvements relate to rendering soft and porous stone impermeable to moisture, and coloring the same by immersing the stone in a boiling solution consisting of coal tar, pitch, bitumen, tallow, and other fatty substances, in the proportion of 85 parts tar, 10 bitumen, 3 tallow, and a small portion of linseed oil. The ingredients are boiled in a suitable vessel, and when they boil the stone is placed on a frame, and lowered into it. The period allowed for the stone to be soaked through is from 8 to 48 hours, according to the size, or if it be only desired that the solution should penetrate the surface, two hours will be sufficient for every inch in depth. Some description of very porous stone will not become filled by a long continued boiling: for such stone there is to be added to the above mixture carbonate of lime, such as chalk or marble, iron rust, granite, and potters' clay, in fine powder; this latter mixture is to be applied to the surface of the stone with a hot iron. If it be required to have the stone of a light colour. instead of tar apply resin of the lightest colour, mixed with turpentine, oils, and all kinds of gum, in the proportion of 15 parts resin to 80 of turpentine, and if the stone is to be of a clear white colour, add white lead, zinc, and carbonate of lime—if any other colour is desired, add to the last compound the dyes usually employed by painters.

CLARKE AND VARLEY'S PNEUMATIC PILE-DRIVER.

The pneumatic pile-driver, which has been erected on the premises of the inventors, is of the full working power, being 36 feet high, the air tube *a* 17 inches diameter, and the monkey weighing 16 cwt. The engine and



air-pumps at present in use are very inadequate to the proper working of this powerful machine, and the air-pumps are only 10 inches diameter—still, even with these, a vacuum is obtained, sufficient to raise the monkey to the summit in one minute; and, by opening a valve *s* below the piston *b*, for the admission of air, it instantly descends; yet such is the perfect control under which it is held, that it can, by the operator at the valve, be arrested in its descent at any part of its fall. There is no time lost in the descent of a catch, as in the old plan—the chain connecting the monkey with the piston being constantly attached, and can be, of course, lengthened or shortened, according to the height of the fall required. The diameter of this tube being 17 inches, the area is nearly 227 inches; and thus allowing only 10 lb. pressure to the inch, this diameter of piston, *b*, would raise a monkey of considerably greater weight.—*Mining Journal.*

The Art of Glass Painting has sustained a loss by the death of M. S. Frank, who died lately at Munich, aged 77. He was one of the first who made experiments for resuscitating several ancient methods of glass staining, which had been lost during the lapse of centuries. Thus, he had been called, in 1818, to Munich, to assist the establishment of the Royal Institution for Glass Paintings.

PROGRESS AT THE NEW HOUSES OF PARLIAMENT.

Our readers will be glad to know what is the actual position of these works; and we are enabled to satisfy them, having recently had occasion to make a hasty survey for ourselves. The fittings up of the House of Lords and of the adjacent apartments proceed apace; and the House itself begins to assume its finished appearance. The details are most gorgeous. No works of modern times can compare with them; yet the impression is one of subdued magnificence. The wood-work is nearly completed and fixed, and the heraldic painter is busy. He is now chiefly employed in inserting the arms of the Lord Chancellors, which are in process of being painted on the upper parts of the pannels along both sides of the chamber. The blank spaces of the walls, to be hereafter painted in fresco, are temporarily hung with crimson drapery, powdered with golden crowns, roses, &c. The reporters' gallery fronts the throne, and is almost as prominent and ornamental an object as her Majesty's seat. The brass railings of the gallery are fitted. This leads into the corridors for Lords and Commons. The many doorways ingeniously form part of the lower panelling of the jambs of the windows. Mr. Barry seems to have heated the rooms without Dr. Reid's aid. We found them of a very agreeable temperature. No stained glass has yet been permanently fitted. Some has been tried;—and the effect is said to have been excellent. It is, we believe, in preparation by Mr. Hardman of Birmingham. The antechamber of the House of Lords, next the throne end, is almost completed:—so is the public hall at the opposite end. In the first, the style of decoration is almost as elaborate as that of the House of Lords itself. Above a fireplace, we observed a large pannel of sculptured wood-work, representing Queen Philippa pleading for the burgesses of Calais. It did not impress us very favourably, on a rapid glance. The position of Edward III., with his crossed legs, looked graceless. In the public hall, we were struck with the magnificence of the floor; on which Minton's Encaustic Tiles—in colours of red, yellow, and cobalt—are in process of laying down. In the centre is a red and white rose of marble, surrounded by brasswork enamelled: and the borders of the tiles are judiciously marked by lines of black Derbyshire marble. The outer gates of the House of Lords are visible from this hall. They are of brass,—and very beautiful is their workmanship. Here, too, the windows are to be of stained glass—but none is yet fitted. These are the only parts of the building which give an idea of what the whole will be when finished.—The House of Commons is very backward—not even roofed in. The central tower is beginning to be seen above the surrounding buildings; and the groining of the arch of the Victoria Tower is turned.—*Athenæum.*

REVIEWS.

First Series of Railway Practice; a collection of working plans and practical details of construction in the public works of the most celebrated engineers. By S. C. BREES, C.E. Third edition, with additional examples. London: Williams & Co., 1847. 4to, pp. 164. Plates.

Of the former editions of this work we have already given favourable reviews. The present edition has had its value considerably increased by numerous improvements and additions. It is a thick quarto volume, handsomely printed and illustrated by seventy folio steel plates, which occupy the greater part of its bulk. These illustrations are not merely showy useless specimens of steel engravings, but have been got up with regard to direct practical utility as well as clearness and neatness of execution.

It might have been of advantage, perhaps, to have made the letter-press explanations more copious. They contain notices of the construction, cost, dimensions, &c., of the different railway structures represented. There are 42 drawings of works on the Birmingham Railway, consisting principally of bridges, retaining walls, and details of tunnel works. Among the subjects of the plates for the Grand Junction Railway, is the aqueduct for the Bridgewater Canal; for the South Eastern Railway, the timber pier in Folkestone Harbour, and the reservoirs and tanks at Tonbridge; for the Greenwich Railway the large 26 feet turnplate at Greenwich with details.

As another series of illustrations of "Railway Practice" is promised, one or two hints for slight improvements may, perhaps, be allowed. In the present work many of the engravings are insufficiently explained, and of several no explanation whatever is given. The specifications for contractors, from which copious extracts are made, are not always trustworthy, as alterations in the plan of operations sometimes occur during the progress of the works. At all events, it would always be more satisfactory to state what had been actually carried into effect, and the difficulties encountered in the undertaking, than to copy out the specification. The latter plan is the easiest, but not the most useful. Lastly, there ought to be a good index, referring not only to the plates, but to the letter-press also. In reality, however, these drawbacks are very slight, for the work is indeed admirably illustrated, and quite worthy of the expense and labour bestowed upon it. To the practical engineer, so large a collection precedents of railway construction must be of great and permanent utility.

Select Writings of ROBERT CHAMBERS. Vol. I. Essay I. London: Orr, 1847. 12mo.

This book does not fall within the scope of our Journal, but from what we can see, seems to contain some well written familiar and humorous essays, by the well-known Edinburgh writer, Mr. R. Chambers. The essay on English ingenuity and enterprise, in a new point of view, is particularly good.

Algebra made Easy. By T. TATE. London: Longman & Co., 1847. 12mo.

This is a small work by the Mathematical Master of the National Society's Training College, Battersea, and is intended to lead the pupil, by an easy transition, from the principles of arithmetic to those of algebra, and is the best adapted for the purpose intended of any that we have seen.

An Introduction to the Present Practice of Surveying and Levelling; with an Appendix. By a CIVIL ENGINEER. London: J. Williams & Co., 1846. 8vo.

The author has treated the subject in a clear and simple manner; his method of keeping the Field book is good. The Appendix might have been left out, as it adds to the bulk of the work, without any adequate advantage. The method of getting up a survey is well explained. The work is illustrated with nine plates.

NEW CORN EXCHANGE, BIRMINGHAM.

It has been determined to erect a new Corn Exchange in Birmingham, immediately behind the St. George's Coach Office, in High Street, between Carr's-lane and Castle-street. The plans have been prepared by Mr. S. Hemming, architect; the building will consist of a hall, 110 feet long by 40 feet wide, lighted by a semi-circular roof, surmounted by a lantern, extending the whole length of the hall. The room will be 50 feet in height, and will be divided into side compartments by pilasters, between which stands and tables, intended to be let to farmers and dealers, will be placed. It is to have a glass roof of semi-circular shape, as the best suited to admit the greatest quantity of light. According to a local paper, this spacious room will have two doors, one leading from a vestibule, with columns and ornamented ceiling, at the entrance of St. George's-court, in High-street, the other with a still larger vestibule at the Castle-street entrance. A porch, ornamented with pilasters of the Roman Doric order, will form the High-street entrance; that by Castle-street, which will be the principal front, will be enriched with eight columns, and ornamental recesses leading to the vestibule and to the floor beneath, which it is proposed shall be appropriated to the exhibition of agricultural implements. The building is of the Roman Doric order, in cement. The extreme length of the building will be 167 feet, the width varying from 37 to 40 feet. The builder is Mr. Briggs, and the cost will be 5,000*l.*

MOULDED BRICKS.

"In a county like ours," says a correspondent of the *Bury Herald*, "where there are no quarries and so many clay pits, and where consequently stone is so dear and scarce, and bricks, both red and white, so common, I rather wonder that brick is not more used for the finer mouldings, in the place of stone. In former times, and it might be equally so now, mouldings of all kinds were highly ornamented, frames to windows, porches, chimneys, &c., were made of brick. Besides being much cheaper, and quite as durable as stone, they had this advantage,—that the most intricate patterns could be made nearly as cheap as the plainest; and also that any colour might be used, if not in the brick itself, yet on the outside

and burnt in. White brick round the windows, or at the corners of houses, proves a good foil to shaped flints; red brick to white, and *vice versa*. I shall mention one or two instances of the use of moulded bricks. Westhorpe hall, one of the first buildings of this class, was erected by Brandon, Duke of Suffolk, about the year 1500, who resided there with his wife, a king's sister and widow. Though hardly a remnant even of the ruins remains, yet fragments turn up which show the beauty of the brick mouldings. They are of a very hard and compact white brick, which retains its original sharpness, and some of them, haying the Duke's crest in relief upon them, still ornament a bridge of the same date as the hall. The other example is West Stow Hall, built by the same duke, the gatehouse of which is a noble specimen of brick building. As an example of the use of brick mouldings in churches, I may name Ixworth Thorp, a doorway of which church has its mouldings and circular arch, formed of red brick."

NOTES ON FOREIGN WORKS.

State of the Gallery of the Louvre, and of French Art in general.—M. Clarac, conservator of the antiques of the French national gallery, has lately died—a loss much to be regretted. The count was the author of the catalogue of antiquities, most valuable also, on account of the fine and accurate description of the materials (metals, stone, &c.), of which the ancients constructed their buildings and ornaments. It is true, that M. Clarac owed much to the notes of his predecessor, M. Visconti—still, the digestion and arrangement are his. The French press blame much the choice of his successor, attributing it to court influence and his seat in the House. They complain also that no care is taken of securing new acquisitions to the Gallery, and speak of antique bronze Silens, &c., purchased lately by either millionaires or Englishmen. These general complaints have become the more pungent, as the works and ideas of Winckelmann seem to acquire great influence in France, and the public naturally expect, that persons so well provided for from the public purse, should be those to continue the researches of that great German art-critic.—A still greater opposition and schism is observable in the department of painting, where a most mediocre catalogue (analogous to that common-place index of the British Museum), is placed in juxta-position with that of the lamented M. Clarac. The very exhibition of the Royal Academy, and still more its prize decisions, are threatened with a most determined opposition; and the first painters have resolved on submitting no more to such a tribunal, and not to send any more pictures to the exhibition. It has been a matter of surprise, that men like Ary Scheffer, Delacroix, Decamps, &c., should have quailed under the dictates of a secret tribunal; and it is quite natural that they, and other painters and sculptors, have resolved on forming an exhibition of their own—that of the artists of Young France. Amongst the most telling members of this opposition is one, of a strong and original mind—M. Barye, the sculptor. His groups in bronze, candelabras, &c., are highly spoken of—and it is much to be regretted, that he is not in the position for exerting himself on some larger work, being neither a knight, nor a F.R., or R.A.

The Paintings and Carvings of St. Bavon, Ghent.—This celebrated ancient edifice seems to have become, of late, a sort of *art-stones*, out of which anything was sold to the highest bidder. In consequence of which, the Belgian legislation have decreed, that no *public* establishment should be allowed to *sell* their objects of art! It is said, that a speculator had, at first, sold some Van Eycks to a German museum for 400,000 francs.—One of the most celebrated Flemish carvers was François Flamand, whose bronzes, terra-cottas, and carvings in wood, are admired in many collections. The two famous altar-pieces of St. Bavon are now in Paris. They also had become the object of judicial litigation between the sellers and the public authorities. They resemble, rather, small chapels, being 12 feet by 15 feet. They are crowded with ornaments of architecture in the Flamboyant or the Florid Gothic style. The one is of 1504, and represents the Life of the Virgin, in four episodes. Most of the figures are worked out in *ronde-bosse* or alto-relievo. The second altar-piece represents the Life of St. Bavon, or St. Benoit, consisting of six very complicated compositions. The style of these carvings, enveloped in festoons and garlands of flowers, and thousand-fold foliage interwoven and interlaced, is very interesting, combining the stern style of Catholicism with the more lively forms of the Renaissance.—The present state of wood carving in France is not encouraging. Except the chair of St. Vincent de Paule, executed by M. Duseigneurs, no other real artistic work of the kind is to be met with. It is not the fault of art, as France possesses some superior statuaries,—but of the public, who have become, it seems, insensible to all but the most flimsy and tawdry productions of art.

M. Violet Leduc, the Restorer of Notre Dame, Paris.—This gentleman, to whom the thorough restoration of that huge building has been intrusted by government, at an expense of one million francs, has been attacked in various ways, of late, by the opponents of Gothic architecture. To this, he has answered in a most triumphant way—asserting, very justly, that *every* real and genuine style of art is good, *if* properly, judiciously, and grandly carried out. The lovers of Gothic architecture have, moreover, lately gained another triumph, in consequence of the municipality of Paris having decreed the erection of the church of Ste. Clotilde in the Gothic style, whose piles are rapidly rising, and promise to be a new ornament to the French metropolis.

Cornelius and Humboldt.—It is now certain that M. Cornelius was obliged to decline the offer of undertaking the frescoes for the internal decoration of the Houses of Parliament at London; previous engagements at Berlin left him, indeed, no alternative in this respect. He has just completed the sketch of a medal, which the King of Prussia intends to present to M. Humboldt as a token for his great work *Cosmos*. The drawing represents the Genius of Science lifting the veil of Nature, personified under the image of a beauteous maiden. The different branches of natural sciences are appropriately represented, and to show clearly that much yet remains unrevealed, a sphynx is seen, to which the Genius points as the object of future inquiries. On the reverse, a likeness of M. Humboldt will be engraven.

Restoration of the Cathedral of Speyer.—This *mummyary* of the old German Empire is to be restored, by order of the King of Bavaria. The cathedral, one of the oldest in Germany, bears some traces of the Byzantine style, and vies in size even with that *ne plus ultra* of mediæval buildings, the Dome of Cölln. The German press speaks highly of the grandeur of the style in which the restoration is contemplated: the architect is the well known Gärtner, of Munich. The frescoes are entrusted to M. Schraudolf, who has already exhibited his vocation for works of high art, in the St. Boniface and All Saints chapels at Munich. Beside him stands Schwarzmann, for the ornamental decoration of the cathedral. The paintings of the vaulted ceiling of the huge choir are already sketched, and the gold ground of Byzantine style completed; and the rich ornamental work of Schwarzmann shows, how this thinking artist knows judiciously to co-ordinate himself and his work to the great *ensemble* to be achieved. The spring will see the completion of the tower, and the lateral choirs and nave will follow in due succession. The principal painting will represent the Life of the Virgin Mary, and that in the southern choir the Life of St. Stephen; the northern choir will be adorned by the deeds of St. Bernard, who preached, in the 12th century, in that very same cathedral, the second Crusade! The figures will be either painted on the gold ground, or be separate fresco paintings. This restoratiou will add much to that wreath of nature and art beauties, by which the banks of the Rhine are so attractive to every sensible mind.

A New Rudder for Large Ships.—M. Fouque, magazineer of the French navy, has submitted to the minister of marine the plan of a new rudder, which has been applied on board the corvette *La Recherche*. The commander of this vessel having certified to the secretary of state, that it was preferable in several instances, and also on account of its solidity, to those in general use, his excellency has given orders to apply M. Fouque's rudders to two vessels of the Port of Toulon, destined for long voyages, in order to try their effect under different climes and latitudes.

Haven of Swinemünde, Prussia.—The government are doing everything towards making this harbour convenient to their own and foreign shipping, as its situation is most advantageous. A large dyke has been constructed, by which the hitherto shallow and sandy embouchure of the Swine has been deepened to upwards of 20 feet, and made accessible even to ships of war. Of late, the bed of this river also has been deepened to 16 feet, from Swinemünde to Stettin. Fortifications, also, in case of war, are con templated.

Gas Lighting at Nüremberg.—We extract the following as a curious specimen of German tenders and contracts: "The gas-manufactory to be completed within the space of a year, so as to supply 300 lanterns—fine for each week of delay in completing contract—£30. The persons hitherto employed in the lighting of the city, to be retained by the new company. The city will require, in all, 530 lights, and a length of pipe of 75,000 feet; the sixth part of the lights to be employed as candelabras, each to cost £7; the lanterns, £3 10s. Each light for public use to be calculated to burn 1,400 hours a year, and 5,000 cubic feet of gas to be kept in reserve. The conducting pipes, which will be subject to a pressure of ten atmospheres prior to being used, are to be calculated for 6,000 lights, at 4½ English cubic feet of gas to be consumed per hour. Each flame of that size has to possess (as ascertained by Rumford's photometer), seven times the strength of a ¼ lb. wax candle. Each of such flames is to be paid for at the rate of 23 fl. 30 xr. (£2), for the yearly calculated burning space of 1400 hours. Private individuals pay for 1000 cubic feet of gas for 25 years, 6 fl. 15 xr., and quantities of gas are also to be had by the gas meter. If purchased without contract, any number not exceeding five lights costs 37 fl.; not exceeding ten, 47 fl.; from forty to sixty, 100 fl., and so on." It is said that the burgomaster of Nüremberg is a very *good calculator;* and so it would appear from this contract, of which we have only given the most important part.

Over-Zeal of Art Collectors.—A very considerable theft of Pompeiian antiquities, frescoes, and bronzes, has been of late discovered in the Museo Borbonico, at Naples. This questionable acquisition was destined for the London market, and was already on board ship for exportation. The throng of travelling collectors, however, throughout Italy is quite astounding, and antiquities are much dearer in Rome and Naples than they are in the Strand or Wardour-street.

The Moving Mountain near Unkel on the Rhine.—Prof. Nöggerath, of Bonn, has delivered a lecture on this curious phenomenon (*ante* p. 63),

by which he has proved that no volcanic agencies—fire or hot vapours—*have occasioned the fall of the mountain. It is merely a land-slip*, occasioned, however, by very complicated causes, resulting from the upheaving of mountains or hills composed of basalt or basaltic conglomerations. Large sections were exhibited by *Prof. Nöggerath*, which he will, no doubt, publish.

Neapolitan Railways and Steamboats.—The activity and progressive tendencies of these have been very great of late. Even ancient Nola is now reached by a side branch of the great Apulian line. An especial communication with Calabria has been established; so much so, that the fine gulf of Palicastro, Cosenza, Catanzano, and the bay of Squilace, become accessible to the curious. All this greatly advances the commerce of the country, and not only taverns and inns, but clubs and festivals, increase; and last but not least, agrarian, historical, and archæological societies, and the latest works on Calabria by Spinelli, Grimaldi, &c. are very reputable productions.

Materials of Ancient and Modern Structures.—Ancient: basalt—syenite—porphyry—granite—marble—freestone—alabaster—lapis lazuli—verde antico—agate—jasper—pozzolana—cedar—oak—sycamore—Corinth brass—copper—gold..... For which the *Moderns* have substituted, in most cases—deal—reeds—cows' hair—paper and papier maché—canvas—glue—paste—pasteboard—plaster of paris—leather—glass—loam—sand!—[Isis of Oken.]

NOTES OF THE MONTH.

Gradual Elevation of the Land at Plymouth.—Attention has recently been drawn to elevations or depressions of the land, with reference to the medium sea level. "In our own immediate neighbourhood," says the *Plymouth Herald*, "proofs of these elevations may be seen. If we land upon the N.E. point of the Mewstone, there is a bank of debris resting upon a stratum of rolled pebbles of all sizes; this raised beach being sheltered from the breakers, remains as an evidence of a change of the relative levels of the Mewstone and sea having taken place. Passing from the Mewstone to the mainland, and coasting round the Sound, we find a succession of these beaches in the cliffs, about 15 or 20 feet above high-water mark; they may be seen at Bovisand, under the Hoe, near Redding Point and Cawsand. But we have other evidence of elevations,—submarine limestone rocks are every where perforated and honeycombed by *Pholades*. About low-water mark and downwards they are every where found alive, but higher up we find them dead; and as high as high-water mark their cells may in some localities be seen. These animals can only live below the mean level, requiring to be altogether under water, or at least covered by every tide. Now, when we find the empty cells of these creatures in the solid limestone rocks under the citadel, but at such a height as would preclude the animals from living in them, we can only infer that the rocks have been raised, or that the sea level has been depressed. Many of these cells may be seen in our locality. The writer had occasion to land a few days ago near the Blockhouse, and directly under the battery at Devil's Point; here he observed that there had been a fissure in the limestone, and a portion of the rock had been removed, leaving a vertical surface of the solid limestone exposed to view. This part of the rock is covered with the cells of the *Sexicava Rugosa*, and above the ordinary high-water level, thereby leaving proof that our shores have been rising slowly and imperceptibly; the place is easily accessible, and anybody may see the spot referred to. If the land be still rising, our harbours will become more shallow; the system now pursued of observing and recording tides and soundings will ultimately settle the point, if engineers will only have the liberality to admit the possibility of former as well as future observations being made correctly."

Thermogenic Drawing.—A scientific correspondent of the *Liverpool Journal* has given the following ingenious mode of transferring the forms of natural objects or the patterns on ribbons to paper:—Saturate common writing paper with porter, coffee mixed with sugar and cream, or a solution of achill, then place the object whose form is to be transferred on the prepared paper and expose them to the action of the sun's rays or those of a common fire. Various other solutions may be used for the same purpose, as bichromate of potash, yellow chromate of potash, &c. When figured satin ribbons are saturated with such solutions and exposed to the sun's rays, the raised patterns are given in beautiful relief in a lighter tint of the same colour as the ground. The principle is capable of a very extended application.

Powerful Voltaic Battery.—Mr. J. Goodman, at the Royal Society, stated that he had succeeded in constructing a voltaic arrangement of some power by fixing a piece of potassium to the end of a copper wire, placed in a tube containing naphtha, and bringing it in contact with a small quantity of mercury, held by a layer of bladder closing the lower end of the tube, which was itself immersed in acidulated water immediately over a piece of platinum, and then completing the circuit by establishing a metallic contact between the copper wire and the platinum. This battery acted with energy on the galvanometer, and effected the decomposition of water. A series of twelve pairs of similar plates exhibited a sensible attraction of a slip of gold leaf. Thus it appears that the substance which possesses the highest chemical affinity manifests also the greatest power of electrical tension.

The Wave of Translation in connexion with the Northern Drift.—Dr. Whewell, in a memoir lately read at the Geological Society, after referring to the northern drift, and the causes that had been suggested for explaining its phenomena, and stating the meaning and properties of the wave of translation, proceeded to discuss some of the results of its operation. He assumed for this purpose a certain quantity of material to be distributed within a given area, and showed by simple calculation different expressions for the amount of paroxysmal force that would be needed. He considers, however, that paroxysmal force is necessary; but that a movement, although small, will, if sudden, produce effects resembling those to be accounted for. He concluded by observing, that a wave of translation differs but little from the *débâcles* assumed by earlier geological speculators.

A good Non-Conductor of Heat.—Mr. J. Nasmyth stated lately, at the Geological Society, an instance of the low conducting power of clay and sand, in which a thickness of half an inch of such matter intercepted the heat of a mass of eleven tons of white-hot melted cast iron for twenty minutes, without the heat on the outside of the vessel being sufficient to pain the hand.

Professor of Mechanical Engineering.—The Council of University College, London, have instituted a professorship of the Mechanical Principles of Engineering, and appointed Mr. Eaton Hodgkinson to the chair.—J. Sowerby, B.A., of Trinity College, has been appointed to a mathematical tutorship in Bishop's College, Calcutta.—Robert Thwaytes, B.A., of Christ's College, Cambridge, has been appointed Professor of Mathematics and Natural Philosphy at Hooghly College, India.

Rouen.—The beautiful ruins of the Abbey which was built at Jumièges, near Rouen, by Robert, one of our early Archbishops of Canterbury, it is stated have been lately purchased, for the purpose of preventing their destruction, by an architect named De Caumont, a relative, we believe, of the M. Adolphe de Caumont, of Caen, who some years ago bought the Abbey at Savigny, near Avranches, for the same good purpose.

Aerial Locomotion—At the Paris Academy of Sciences. Feb. 1., M. Babinet, in his own name and that of MM. Poncelet and Séguier, read a paper recently presented by M. Van Hecke, of Brussels, on a new system of aërial locomotion. M. Van Hecke formally renounces the idea of seeking for a *point d'appui* in the air to navigate against the wind. His system consists, like that of Meusnier, in seeking, at different heights, currents favourable to the direction which he may wish to take. Meusnier thought he should be able to effect this by compressing or dilating the air in his balloon. M. Van Hecke has found a more simple means of ascending and descending without loss of ballast or gas. He has invented an apparatus analogous to wings, and which he has placed under the eyes of the committee. With this he has an ascending or descending force equal to from 2 to 3 kilogrammes; but with four of these motive powers applied to his car he would have a force of from 10 to 12 kilogrammes,—and with a large apparatus he might reach 100. The report of the committee is favourable to the principle of the discovery.

New System for Propelling Vessels.—Extract of a letter from Boulogne, in the *Herald*, announces that "a considerable degree of interest has been excited here by certain experiments made upon an entirely new system for propelling vessels; which, if capable of being carried out upon a large principle, must not only supersede paddle-wheels, but also the Archimedean screw. It has long been considered a matter of impossibility that the principle of the paddle-wheel could be rendered of any useful effect when totally submerged. The present invention has demonstrated to a certainty that such a disadvantage can be overcome. The experiments were effected by hand labour; the motive force being fitted into the stern of a pilot boat.—The principle is based on the well-known properties of the parabola as respects light, and the same properties are proved to be true as respects hydrostatics. The blades are sections of a parabola; and are so constructed as to impinge on the concave surface, whereby the water is grasped and compressed to the centre of the axis, and thrown off in a direct line with the plane of the vessel's course,—thereby rendering the propulsion superior in efficiency to the common paddle-wheel, being uniform and continuous without drawback in respect of back-water. Another advantage exists in the area of surface as compared with the screw; as less than one-half of parabolic areas will work more efficiently with the same power."

Hamburg.—Dec. 19.—"Mr. George Giles, who during the last eight years has been actively engaged in constructing the Hamburg-Bergedorf railway, the new sewage and water works, the navigation locks, canals, bridges, &c., quitted us on the 16th inst., to enter on a more extended field of professional occupation in England. Previous to his departure, he had the gratification of experiencing the high estimation in which he is held by all branches of our government and a large circle of friends. Our Senate presented to him a decree of that venerable body, expressive of their unanimous thanks for his zealous exertions on their behalf; this was accompanied by the large honorary medal, intended as a special token of their grateful recollection of Mr. Giles's heroism, energy, and skill in conducting a series of explosions at the dreadful fire of the 5th to the 9th May, 1832, which devastated nearly the one-fourth part of our ancient city. On the 14th inst., a large meeting of gentlemen, comprising senators, members of the board of works and board of exchequer, the directors

of the Hamburg-Bergedorf railway, and several other of our most influential citizens, invited Mr. Giles to a grand dinner at Streit's Hotel, on which occasion they presented him with a handsome piece of plate, and an address, testifying their high appreciation of his professional and private worth; expressing at the same time their deep regrets at his retirement from among them."—*Hamburgh Paper.*

King's College Engineering Society.—A Society has been instituted by the students of the Department of Applied Sciences, King's College, London, for the purpose of the reading of Essays, the taking in of the various scientific publications, and forming a library of works connected with the Department. There is at present a small library, quite inadequate to the purpose, and we are surprised the Council of the College have not provided the students with a better one. The students have been much assisted in the formation of the Society by the Rev. M. O'Brien, M.A., Dean of the Department, and by the other Professors.

The Royal Academy.—In the Architectural department the Gold Medal and the Discourses of Reynolds and West, will be given for the best design for a Gothic church, the whole comprised in one general and regular composition. The design must be as large as an entire sheet of double elephant will admit, and to consist of a plan, elevation, section, and perspective view. A Silver Medal will be given for the best figured drawing of the entrance and interior of the Temple Church.

Photographic Portraits.—Continued improvements are being made in photography. The latest which we have to record is the work of Mr. Kilburn, who has opened an establishment in Regent-street, where the specimens on view are among the most perfect that we have yet seen. The principal improvement is in colour, which, in Mr. Kilburn's portraits, has not the prevailing defect of faintness, but possesses the depth and body of a finished painting. This quality renders a portrait valuable as a work of art, which is otherwise rarely the case—the likeness being generally the only recommendation. Indeed, the process of colouring requires the same care and skill as in an ivory miniature. Nor is this attention ill bestowed, for the distinctness thus given to the subject has hitherto been a great desideratum, the polished surface of the picture in most cases requiring a peculiar direction of the light in order to distinguish its details.—*Daily News.*

Westminster Abbey.—It is stated that the Dean and Chapter of Westminster have very laudably determined on restoring to the tombs of Queen Eleanor and King Henry V. the rich old contemporary iron-work, taken down on the recommendation of Sir Francis Chantrey, sold at so much a cwt. to an ironmonger in Westminster, and subsequently rebought by the Dean and Chapter, and allowed to rust in an adjoining vault. This iron-work forms an integral part of each monument—the sculptor and smith generally working, in mediæval times, in the same spirit and to the same end. Chantrey's reason for recommending the removal of the whole of the iron-work throughout the Abbey was, that it too often served as steps or ladders to the Westminster boys to mutilate noses, &c., merely from wantonness; and to over curious collectors to climb to portions of monuments otherwise beyond their reach. In many of the modern monuments the iron-work was erected merely for protection, and not unoften disfigured the monument it was placed before. Here the recommendation was judicious, but when it was extended to mediæval monuments, a piece of barbarism was committed not likely, we think and trust, to occur again.—A paper on the same subject was read at a late meeting of the Freemasons of the Church, by Mr. John Brown. He stated that in the Blaize chapel, in the Abbey, is deposited the iron canopy which formerly surmounted the beautiful tomb of Queen Eleanor. Neale, in his "History of Westminster," mentions that "since the coronation, a considerable improvement has been effected in the interior appearance of the Abbey Church, by a general cleaning of the monuments and the removal of the iron-work which screened them." Now, at this coronation, which must have been that of George the Fourth, the iron-work not only of the tomb of Queen Eleanor, but that of Henry V., were placed in the dark recesses of the Blaize chapel, where they have been seldom viewed by parties who have visited the Abbey. The tomb of Henry V. is at the east end of the chapel; the head of the king, which the vergers say was made of silver, was taken away in the time of the troubles. Neale says "*all the damage in the Abbey was not done in the time of the troubles.*"

OBITUARY.

We regret to record the death of the distinguished artist, William Collins, R.A., which took place on the 17th ult., at his residence, Devonport-street, Hyde-park-gardens. Mr. Collins was in his 59th year. Critics in art associate the name of Collins with everything that is pleasing in rural life. "Children picking Hops," "Children gathering Blackberries," and "Children examining the Contents of a Net;" with everything that is connected with the life of a fisherman on the sea coast, "Fishermen coming Ashore before Sunrise," "Fishermen on the Look-out," and "Fishermen getting out their Nets." Mr. Collins was the son of a picture dealer and cleaner—a man of ready wit—but best remembered by his "Life of Morland, the Painter." His son William was born in 1788, and exhibited for the first time at the Royal Academy, in the year 1809, at the age of twenty-one. In 1815, he was elected an associate of the Royal Academy, and in 1829 a royal academician. A very considerable alteration was made by Mr. Collins in his style and manner of painting after his visit to Italy in the years 1837 and 1838. Like his friend Wilkie, he became ambitious of greater efforts, and visitors at the Academy were surprised to see an old favourite quitting his sea shore scenes, his muscle gatherers, and shrimpers, for "The Two Disciples of Emmaus," and "Our Saviour with the Doctors in the Temple." The latter picture is now at Bowood, the seat of the Marquis of Lansdowne. The head of Christ is uncommonly poor—the heads of the doctors finely painted, but rather vulgarly conceived. The colouring is very powerful and harmonious. But it is not by his more ambitious efforts that Mr. Collins will be tried; some of his sea-shore scenes are exquisitely true to nature: and his "Rustic Civility," (boys opening a gate,) and his "Happy as a King," (a boy swinging on the top of a gate,) are incidents happily conceived and charmingly painted. His "Fetching the Doctor," in the exhibition of 1845, possesses a quiet humour different altogether from any of his former efforts. Mr. Collins received a large price for his pictures.

RAILWAY INTELLIGENCE.

Trent Valley.—The works on this line are fast advancing towards completion. The tunnel is driven through, and nearly all bricked, and in a few days will be finished. All the cuttings are done, as are also all the bridges, and the whole of the line will be completed in a few weeks; but as it will be necessary to let the works consolidate, the 1st of May has been named by the directors for opening.

Dundalk and Enniskillen.—The works on this line are in such a forward state that it will be opened for passengers in November next.

Londonderry and Enniskillen.—This line, between Strabane and Derry, is nearly completed, and about to be opened.

Communication between Trieste and the Rhine.—The governments of Austria and Bavaria have come to an agreement for establishing direct railway communication from Trieste to the Rhine. The agreement is to extend to Salzburg the line from Trieste to Vienna, on which the Austrian government is actively employed, and afterwards carry it as far as Munich.

Cost of constructing Railways in France.—The financial reports presented to the French government by the engineers charged with the construction of the three railways in the centre of France, give the following estimate of the expense. The section between Vierzon and the confluence of the Allier and the Loire, the length of which is 32,194 metres, will cost 5,600,000f., or 173,945f. per kilometre. The section from Vierzon to Chateauroux, of the length of 59,691 metres, will cost 8,260,000f., being 138,379f. per kilometre. The section from Chateauroux to Limoges, the length of which is 76,419 metres, will cost 15,000,000f., or 196,286f. per kilometre. These three sections will therefore cost 28,860,000f., including the compensation for ground, works of art, guard-houses, &c.

Railway from the Adriatic to the North Sea.—Extract of a letter from Vienna: "The establishment of a railway from the coast of the Adriatic to the North Sea will probably meet with no other obstacles than those presented by the immense extent of the line and the nature of the soil. At present it is difficult to decide whether this line will be finished sooner than that from Marseilles to the Dover Straits. We, however, think that the German line will be the first completed, from the fact that several large sections are already constructed, viz.: from Cilley to Bruck, from Munich to Augsburg, from Bruchsat to Manheim, from Bonn to Cologne, and from Cologne to Ostend. Bavaria displays the greatest activity in uniting its railways with those of Austria by the frontier of the circle of Salzburg.

Amiens and Boulogne.—Opening of the Abbeville Section.—This line, which will offer such facilities for intercourse between Paris and London, as it unites with the Northern line at Amiens, is in such an advanced state that the opening of the Amiens and Abbeville section is fixed for the 1st instant. This section is 45 kilometres in length, and is divided into seven stations, viz.: Amiens, the point of departure, Aitly, Picquigny, Hangest, Longpre, Pont Remy, and Abbeville. The company has just submitted to the superior administration its rate of charges for passengers, parcels, fish, merchandise, &c.

Rouen and Havre.—The council of *ponts et chaussées* has not yet come to a decision respecting the further tests which are to be applied to the viaducts on this line to determine the solidity of the works. In the meanwhile, however, the company is making active preparations for opening the line in the beginning of this month. The intended rate of charges has been submitted to the authorities. The length of the line is 95 kilometres, and there will be the following 11 stations:—Rouen, Maromme, Malawnay, Barentin, Panilly, Motiville, Eyvetat, Alvimare, St. Romain, Harfleur, and Havre.

London, Brighton, and South Coast.—The Lords of the Admiralty have given their sanction to the proposed alterations in connexion with this line at Newhaven harbour. The works on the line are rapidly progressing in several parts, and the works at the harbour will commence immediately.

The Birkenhead and Chester Extension will, it is said, be opened on the 31st of March.

Reading and Hungerford.—The branch line of rail from Reading to Hungerford, through Newbury, is rapidly progressing, and it is expected will be fully completed for the general traffic by the first of June. The branch line will be 26 miles in length.

Ipswich and Bury.—Extension to Norwich.—Mr. Locke has completed a re-survey of this line, by which it has been much improved, and the work and time for completion has been diminished. The contract for the entire line has been let to Messrs. Brassey. Active operations upon the heaviest part of the line will commence immediately.

Waterford and Limerick Railway.—The Treasury minute has been received, authorising the above company to construct 50 miles of earth-works. Thus will many thousands be employed immediately on a truly reproductive work, and the labour-rate will cease on the baronies through which it passes—at least in a great measure. Twenty-eight miles of this railway opens from Limerick to Tipperary on the first of May. The engines and carriages are ready; the latter were all manufactured in Ireland.

Aberdeen.—The greatest activity prevails at the present time on nearly all the contracts taken of this line. From Aberdeen to the south a commencement has already been made. The contractors for the bridge to be erected over the Manse of Fellereson have already broken the ground, and a strong muster of workmen have been placed on the works. On the contract extending from Glennery distillery to Black-hill, there are at the present time nearly 200 labourers employed, and four of the cuts are nearly ready for the wagon-work. On the contract extending from Black-hill to Elsick, there are a great number of men employed; and, on what is termed Forbe's contract, there are upwards of 1,000 men engaged.

Leeds and Bradford Extension.—The railway between Shipley and Keighley is progressing rapidly, with the exception of that part near Bingley Church, called the Bingley Bog. Sixty tons of earth and stones are cast into this bog every hour of the day. The earth and stones on the east end are conveyed by steam from the Nobwood, and from the west by horses. Notwithstanding this immense quantity being dropped into the gulf at both ends by three lines of rails, all is swallowed up every morning; the heavy matter sinking thus, forces the lighter up, and makes a black spongy embankment on both sides.

German Railways.—The *Deutsche Allgemeine Zeitung* of the 27th of January, contains a review of the statistics of German railways, of which the following is an abridgment:—At the commencement of the present year, the entire length of all the German railways which are regularly open to circulation was 592 geographical German miles, of which 26 are tram-lines, 173 belong to various governments, and 419 to private companies. Out of the 173 miles of state lines, Austria possesses 64½; Baden, 35½; Bavaria, 31½; Brunswick, 15½; Hanover, 12½; Hesse-Darmstadt, nearly 6½; Wurtemberg, rather more than 5; and Frankfort, somewhat more than ½. The private lines are possessed by 29 companies. The longest is the Lower Silesian one, which is 51·44 geographical miles, and runs from Berlin to Breslaw, with a branch line to Hennersdorf. The next in length is the Emperor Ferdinand North Railway (40·92 miles), extending from Vienna to Brunn, Olmutz, Leipnik, and Stockerau. The Berlin and Hamburg line is 36·58 miles; the Upper Silesian (from Breslaw to Myslowitz), 36·93 miles; the Budweis Lintz and Ginunden Korne line, 26·13 miles; the Berlin and Stettin, with a branch line from the latter to Stargard, 22·63 miles; the Berlin and Cothen, 20·51 miles; the Berlin, Potsdam, and Magdeburg, 19·63 miles; the Vienna and Gloggnitz, with branch lines from Modling to Laxenburg, and from Vienna to Bruck, on the Leitha, 16·14 miles; the Magdeburg and Leipsic, 16·1 miles; the Leipsic and Dresden, 15·48 miles; the Altona and Kiel, 14·29 miles; the Saxo-Bavarian (from Leipsic to Reichenbach, with a branch line to Zwickau), 14·13 miles; the Rhenish (from Cologne to Aix-la-Chapelle and the Belgian frontiers), 11·57 miles; the Thuringian (from Weissanfels to Weimar), 11·50 miles; the Saxo-Silesian (from Glogau to Sagan), 9·67 miles; the Breslaw and Freiburgh, 8·96 miles; the Cologne and Minden (from Deutz to Duisburg), 8·54 miles; the Magdeburgh and Halberstadt, 7·84 miles; the Taunus (from Frankfort to Mainz and Wiesbaden), 5·85 miles; the Rendsburg and Neumunster, 4·41 miles; the Dusseldorf and Elberfeld, 3·57 miles; the Anhalt and Bernburg, 2·33 miles; the Cosel and Ratibor, 4·25 miles; the Bonn and Cologne, 3·95 miles; the Gluckstadt and Elmshorn, 2·22 miles; the Hamburg and Bergedorf, 2·17 miles; and the Nuremberg and Furth, 0·81 mile. Twenty out of the 38 states of Germany have railways at present. There are only two railways which are completely finished, and provided throughout their entire length with double lines—the Leipsic and Dresden and the Magdeburg and Leipsic. The number of tunnels on the German lines open to circulation are 16, of which 5 are on the Rhenish Railway, 2 on the Wurtemberg; 4 on the South Austrian (between the Gratz and Cilley); 3 on the North Austrian (between Olmutz and Prague); 1 on the Bavarian state line (at Erlangen), and 1 between Leipsic and Dresden. The longest is on the Rhenish, at Konigsdorf, between Cologne and Aix-la-Chapelle, being 5,160 feet.

Italian Railways.—The section of the railway from San Giuliano to Pisa has been opened, and the whole line from Pisa to Lucca is thus open to traffic. The average number of passengers between San Giuliano and Pisa was computed at 512 daily. The company of the Lucca and Postoja Railway held a second general meeting on the 30th October. The report of Engineer Pohlmayer was read, who has been appointed by a Bolognese company to study the continuation of the Appennine railway between Poretta and Bologna. According to his report the works between Lucca and Altopascio, a length of 13,700 metres, are in an advanced state, and this section will probably be thrown open to the public next spring.—The works are also going on actively on the Sienna Railway.

Whitehaven and Maryport Railway is open for goods, and to be opened for passenger traffic on the 1st of March.

German Railways.—On the 6th ult. an experimental train went from Hanover to Harburg, situated on the left bank of the Elbe, nearly opposite to Hamburg. The line will be open to the public on the 1st of May next. The section from Hanover to Minden, which will complete the Berlin and Cologne Railway, is also expected to be opened this year. As soon as this line is completed, there will be railway communications between Paris, Berlin, Hamburg, Breslau, and the Austrian frontier.

LIST OF NEW PATENTS.

GRANTED IN ENGLAND FROM JANUARY 21, TO FEBRUARY 19, 1847.

Six Months allowed for Enrolment, unless otherwise expressed.

William Breynton, of the Inner Temple, London, Esq., for "certain Improvements in rotatory engines."—Sealed January 21.

Francis Preston, of Ardwick, near Manchester, spindle-maker, for "certain Improvements in machinery or apparatus to be used in the preparation of cotton and other fibrous substances for spinning."—January 23.

Frederick William Jowett, of Burton-upon-Trent, Stafford, engineer, for "certain Improvements in telegraphic communications."—January 23.

Clemence Augustus Kurtz, of Manchester, Lancaster, manufacturing chemist, for "a new manufacture of a certain colouring matter; to be used in the dyeing or in the printing of woollen, cotton, silk, and other fabrics."—January 26.

Richard Walker, of Rochdale, Lancaster, cotton spinner, for "certain Improvements in the apparatus for the manufacture of gas for illumination, which said improvements are applicable to the manufacture of other products of distillation."—January 26.

William Phillips Parker, of 48, Lime-street, London, gentleman, for "Improvements in bell machinery." (A communication.)—January 28.

Thomas Webster Rammell, of 12, Dorset-place, Dorset-square, Middlesex, civil engineer, for "Improvements in the preparation and application of cork for linings and other useful purposes."—January 28.

Elizabeth Oudinot Lutel, of Addle-street, London, for producing a certain texture elastic in some parts." (A communication.)—January 28.

James Taylor, of Furnival's Inn, Middlesex, gentleman, for "an Improved apparatus for boring into the earth." (A communication.)—January 28.

Peter Armand Lecomte de Fontainemoreau, of 15, New Broad-street, London, for "certain Improvements in the process and apparatus for treating fatty bodies and the matters producing them, such process and apparatus being equally applicable to the treating several other substances, and also for the process and apparatus necessary for the useful applicable of all those products."—January 28.

John Law, of York-place, Portman-square, Middlesex, gentleman, for "Improvements in yarns, and the machinery by which the same are manufactured." (A communication.)—January 28.

John Braithwaite, of 39, Bedford-square, Middlesex, civil engineer, for "certain Improvements in heating, lighting, and ventilating."—January 28.

Thomas Barnabas Daft, of Birmingham, gentleman, for "Improvements in constructing inkstands, and in fastenings to elastic bands."—February 1.

Richard Albert Tilghman, of Scott's Yard, Bush Lane, in the city of London, for "Improvements in the manufacture of certain acids, alkalies, and alkaline salts."—Feb. 1.

Edward Newman Fourdrinier, of Cheddleton, in the county of Stafford, paper manufacturer, for "Improvements in apparatus to be used for raising and lowering weights from mines and other places."—Feb. 1.

John Thompson Carter, of Drogheda, in the county of the town of Drogheda, in Ireland, flax-spinner, for "Improvements in machinery for crushing, bruising, and preparing flax, hemp, and other fibrous materials requiring such treatment."—Feb. 1.

Marco Henry Franzoni, of Carrara, but now residing at Pelham Place, Brompton, Middlesex, sculptor, for "Improvements in obtaining and applying motive power."—Feb. 1.

Benjamin Dawson Morton, of Cranford Bridge, Middlesex, gentleman, for "certain Improvements in cranes, and other hoisting and lowering machinery."—Feb. 1.

Uriah Clarke, of Leicester, in the county of Leicester, and Henry Barber, of the same place, fuller and dresser, for "certain Improvements in the manufacture of looped and woven fabrics."—February 1.

William Pidding, of Bernard-street, Middlesex, gentleman, for "an Improved mode of exhibiting and protecting certain coloured fabrics, ornamental inscriptions, and other designs."—Feb. 2.

George Grundy, of Manchester, manager, for "certain Improvements in furnaces, and in flues and tiles used in the construction thereof."—February 8.

Christopher Vaux, of Frederick-street, London, gentleman, for "Improvements in storing and supplying beer, ale, and porter."—February 8.

Thomas Brown Jordan, of Belvidere-road, Surrey, for "certain Improvements in machinery for working mouldings."—February 8.

Thomas Du Boulay, Esq., of Sandgate, Kent, and John Du Boulay, Esq., in the county of Dorset, for "Improvements in fitting up granaries and warehouses, and of getting into condition and preserving therein grain, pulse, seeds, malt, and other perishable articles."—February 8.

William S. Kennedy, of Burslem, porcelain manufacturer, for "Improvements in attaching plain or ornamental surfaces of earthenware, china, or glass, to articles made of metal, wood, or other materials."—February 8.

John Loach, of Birmingham, brass founder, for a "certain Improved fastening, or certain improved fastenings, for windows, shutters, doors, and tables; applicable also as a fastening or fastenings generally."—February 8.

Alexander Doull, of Euston Grove, Middlesex, civil engineer, for "certain Improvements in railway, steamboat, and other signals."—February 8.

Stephen Geary, of No. 10, Hamilton-place, New-road, Middlesex, for "certain Improvements in obtaining and applying motive power."—February 8.

John Gedge, of 4, Wellington-street, Strand, Middlesex, for "certain Improvements in the machinery or apparatus used for watering grain."—February 8.

Enoch Wilkinson, of Oldham, in the county of Lancaster, overlooker, for "certain Improvements in looms for weaving."—February 9.

William Eaton, of Camberwell, Surrey, engineer, for "Improvements in machinery for twisting cotton or other fibrous substances."—February 9.

Stephen Moulton, of Norfolk-street, Strand, gentleman, for "Improvements in wearing caoutchouc with other materials to produce elastic and impermeable compounds."—(A communication.) February 9.

Charles Hancock, of Grosvenor-place, Middlesex, gentleman, for "Improvements in the preparation of gutta percha, and in the application thereof, alone, and in combination with other materials, to manufacturing purposes, which improvements are also applicable to other substances."—February 10.

Alfred Brett, of Holborn-bars, gentleman, and George Little, of High Holborn, electrical engineer, for "Improvements in electric telegraphs, and in the arrangements and apparatus to be used therein and therewith, part of which improvements are also applicable to time-keepers and other useful purposes."—Feb. 11.

Egbert Hedge, residing at No. 7, Howard-street, in the parish of St. Clement Danes, Middlesex, gentleman, for "certain Improvements in rails for railways, and in the manner of securing them."—Feb. 12.

William Edward Newton, of No. 66, Chancery-lane, Middlesex, for "Improvements in aerial locomotion." (A communication.)—Feb. 15.

Solomon Leatham, of Leeds, York, overlooker, for "Improvements in roving and spinning flax and other fibres."—Feb. 15.

Francis Henry Waller, of Harrington-square, Middlesex, surgeon, for "Improvements in apparatus for making and filtering infusions of coffee and other articles."—February 16.

Robert Stirling Newall, of Gateshead, Esq., for "certain Improvements in locomotive engines."—February 16.

Phillip Henry Holland, of Chorlton-upon-Medlock, Manchester, for "Improvements in applying manure to land." (A communication.)—February 16.

Nathaniel Card, of Manchester, twine manufacturer, for "certain Improvements in machinery or apparatus for twisting, twining, or manufacturing cords, bands, and other similar articles from cotton, flax, hemp, silk, and other fibrous yarns or threads."—Feb. 16.

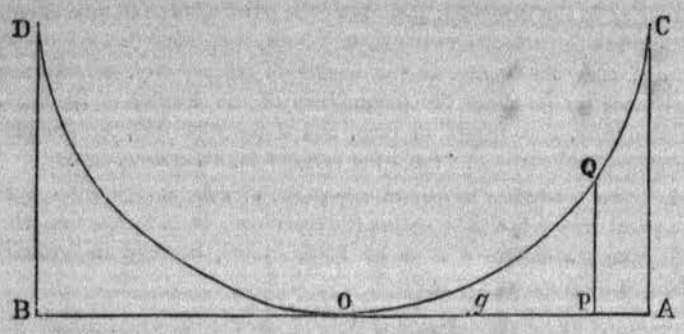
Francois Stanislaus Meldon De Sussex, of Millwall, Middlesex, for "Improvements in the manufacture of chlorine, hydrochloric acid, and nitric acid, and obtaining several products therefrom."—February 19.

Alexander Bain, of Upper Baker-street, Middlesex, electrical engineer, for "Improvements in clocks and time-keepers, and in apparatus connected therewith."—Feb. 19.

Thomas Breamwell, of Newcastle-upon-Tyne, manufacturing chemist, for "Improvements in furnaces and apparatus to render atmospheric air available in producing cyanides and certain other compounds, which improvements in furnaces and apparatus may also be employed for other purposes."—October 8, 1846.—[This patent was opposed by caveat sealed on the 31st January, 1847; but dated 8th October, 1846, the day the patent would have been sealed, if not opposed by caveat, by order of the Lord Chancellor.]

STRAIN ON THE PLATFORM OF A SUSPENSION BRIDGE.

In the following paper it is proposed to examine the nature and amount of the strain to which the platform of a suspension bridge is subjected, by its connection with the chains and piers, and a load equally or unequally distributed throughout its length. We shall assume that the platform is rigid, the curve of the chain a catenary, the links indefinitely short compared with the length of the platform, and the rods indefinitely close to each other and inextensible.



Let O, the centre of the platform, be taken for origin; the axis of the platform, which we suppose horizontal, for axis of x; and a vertical through O, for the axis of y. Let dt be taken to represent the tension of the rod applied at point $(x\,y)$ of the chain; T the tension of the chain at that point; l the weight of a unit's length of chain,—then we shall have

$$d\left(\mathrm{T}\frac{dy}{ds}\right) = dt + l\,ds;\quad d\left(\mathrm{T}\frac{dx}{ds}\right) = 0.$$

$$\mathrm{T}\frac{dy}{ds} = t + ls;\ \text{and}\ \mathrm{T}\frac{dx}{ds} = c;\quad \therefore \frac{dy}{dx} = \frac{t + s\,l}{c}.$$

But in the common catenary,

$$\frac{dy}{dx} = c's,\ c' \text{ being an arbitrary constant;}$$

$\therefore t$ must $= \mu s$, where μ is some constant. Consequently, the resultant of all the tensions of the rods, attached to any portion of the chain, passes through the centre of gravity of that portion. If, now, the platform be supposed uniformly loaded throughout, and perfectly rigid, it would be impossible to determine whether its weight were wholly supported by the chains, or wholly by the platform,—or how it might be divided between them; but as the nature of the materials we are considering is only so far rigid, that neither the flexibility of the platform, nor the extensibility of the rods and chains, are supposed to be sufficiently great to affect the curve which the chains assume, a very little consideration will be sufficient to show that the weight of the platform will be so distributed, that the tendency to bend it will be a minimum. When the platform is unequally loaded, if we suppose the load not sufficiently great sensibly to deflect it, it will be hereafter shown that a pressure will be generated on that pier nearest to the centre of gravity of the platform. In practice, however, if the load were much increased and unequally distributed, the platform would bend, and the curve assumed by the chains would be modified; the point where the resultant of all the vertical tensions of the rods meets the platform, approaching nearer to the centre of gravity of the platform and load, and, in case disruption ensued, actually and suddenly coinciding with it.

To find the strain on any point of a platform equally loaded throughout:—

Let P be a point in the platform, and P Q vertical thereto; $\mathrm{AP} = x$; $\mathrm{AO} = \mathrm{OB} = a$; $\mathrm{CQ} = \mathrm{S'}$ $\mathrm{QD} = \mathrm{S''}$

W = weight of platform and load; $\mathrm{T'}$ = tension of rods from P to A; K distance of the centre of gravity of CQ from P.

Let $\mathrm{T'} = \mathrm{V\,S}$, where V is determined from the equation $\mathrm{VS'} + \mathrm{VS''} = \mathrm{W}$.

Then the moment tending to turn AP about P, which measures the strain at P, is given by the equation—

$$\text{Moment of strain} = \mathrm{VS'K} - \mathrm{W}.\frac{\mathrm{C}\,x}{4a}.$$

If the load be unequally distributed,—

Let G be the centre of gravity of load and platform; S the whole length of the chain.

Then a pressure will be exerted where the platform rests on the pier nearest to G. Let X = this pressure.

Taking moments about O, if $\mathrm{O\,G} = h$; $\mathrm{W}h = a\mathrm{X'}$; $\mathrm{W} = \mathrm{X} + \mathrm{VS}$;

$$\therefore \mathrm{V} = \mathrm{W}\left(\frac{a-h}{a\,\mathrm{S}}\right).$$

And for the strain at P, if $\mathrm{W'}$ = weight of platform, AP, and its load,—

p the distance of its centre of gravity from P;

Moment tending to turn A P round P =

$$\mathrm{W}\frac{h}{a}x + \mathrm{V\,K\,S'} - \mathrm{W'}p = \mathrm{W}\frac{h}{a}x + \mathrm{W}.\frac{a-h}{a}\frac{\mathrm{S'}}{\mathrm{S}} - \mathrm{W'}p.$$

Deductions from the above formulæ :—

1st. When the platform is equally loaded throughout, the strain will be least when the chain has but a slight depression; for then, $\mathrm{V'\,S'\,K}$ will most nearly, *cæteris paribus*, equal $\mathrm{W}\frac{\mathrm{C}\,x}{4a}$.

2nd. The strain of a load, unequally and unsymmetrically distributed, will always be greater than the strain produced by the same load equally distributed.

J. H. R.

[In the remarks appended to Sir Howard Douglas's paper in our last number, it was observed that several topics were passed over for the sake of brevity. Lest it should be inferred that there were still wide differences of opinion (which is not the case), it may be remarked that the topics referred to were not of a controversial nature, and that this question of the strain on the platform of a suspension bridge was one of the most important of them.]

ON THE MOTION OF FLUIDS.

The discrepancy between theory and experiment in all problems concerning the flow of water has been universally acknowledged. This extraordinary fact has hitherto been accounted for on the supposition of the imperfect character of the fluidity of that liquid; whereas, as we shall presently show, it is not the water but the analysis—not nature but the philosophers who are at fault. In the present paper we shall point out some of the fundamental errors of analytical hydrodynamics, and endeavour to show how theory and practice can be reconciled. Some time since, one of the most eminent of living mathematicians pointed out to us the incorrectness of certain analysis connected with the motion of a wave along a canal, in which, as he clearly proved, the hypotheses adopted were inconsistent with themselves; that is, parallel motion and perfect continuity were assumed to co-exist. Our attention has since been more recently directed to the subject, and having taken Professor Miller's work as a text-book, we were astonished to find the same two assumptions vitiating the whole of the chapter on fluid motion.

In section V. of Miller, the first sentence runs thus—

"When an incompressible fluid flows through a tube, the velocities of the fluid at any two points, are inversely proportional to the areas of the perpendicular sections of the tube at those points; supposing the tube to continue always full, and the velocities at all points in the same section to be equal to one another, and perpendicular to the section."

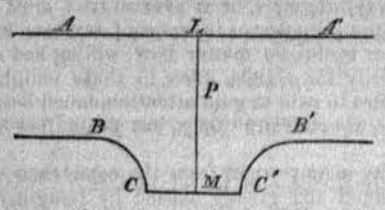
The two hypotheses with which this paragraph concludes are inconsistent. Let the tube be of variable bore and its axis straight, let this axis be the axis of x, and let u, v, w, be the velocities of any fluid particle parallel to the axes of x, y, z, respectively; then, by the equation of continuity for incompressible homogeneous fluids, we have

$$\frac{du}{dx} + \frac{dv}{dy} + \frac{dw}{dz} = 0$$

Now v and w both $= 0$, by the hypothesis; $\therefore \frac{du}{dx} = 0 \therefore u = c$,

—which is absurd.

In determining the motion of water issuing from a *very* small orifice in the bottom of a cylindrical vessel, it is clear that the tube may be considered of unequal but continuous bore, how then can we find the quantity discharged from the orifice? This we shall endeavour to do approximately. We shall first however seek for the maximum velocity of the issuing stream near the orifice.



Suppose B B′ the orifice, A A′ a horizontal section of the fluid above B B′, taken at such a height above B B′, that all the fluid beyond A A′ may be considered at rest. L M the axis of the stream. P any point in L M. Then the motion at P may be supposed wholly vertical. Since L M is the axis of the stream, if then L P $= z$, v be the velocity at P, the density of water 1, and g the measure of the accelerating force of gravity, and p the pressure at P, we shall have

$$v\frac{dv}{dz} = g - \frac{dp}{dz} \quad \therefore \frac{v^2}{2} = gz - p + C.$$

Let now h be the depth of B B′ below the surface of the water in the vessel, the distance between B B′ and A A′ $= \delta h$, then we have

$$0 = -g\{h - \delta h\} + C - \pi,$$

because if π = atmospheric pressure, $\pi + g\{h - \delta h\}$ = pressure at L

$$\therefore \frac{v^2}{2} = \pi + gz - p + g\{h - \delta h\}.$$

So far as p is concerned, the velocity will be greatest when p is least. Let k be the value of z when p has its least value, which is clearly π.

$$\therefore \frac{v^2}{2} = g\{h - \delta h + k\},$$

k and δh being both extremely small. This expression becomes $\frac{v^2}{2} = gh$. This, as far as it goes, apparently agrees with the method of finding v, given in the books. We may remark, however, that in all demonstrations we have seen, the great error is committed of estimating the motion from the surface of the fluid, and assuming all particles in the same horizontal section to have the same vertical velocities. Now in fact p becomes discontinious near the orifice, and when the orifice is indefinitely small passes suddenly from $p = gh + \pi$ to $p = \pi$, and consequently the equal number for v, which assume the continuity of p, cannot be applied without further adaptation.

To determine the velocity and quantity emitted at the orifice, requires an altogether different kind of investigation.

We shall here suppose that the tube is full, and that the fluid is vertically at rest within the vessel, even close to the opening; this, although not strictly correct, will be found near enough to give tolerably accurate results.

Let A = area of orifice. At time t from the commencement of the motion,—suppose that if the jet had moved with a velocity in all its parallel sections equal to its mean velocity of projection at B B′, it would have extended to a small distance, x, from B B′. At time $t + \delta t$, let x become $x + \delta x$, then an additional quantity, $Av\delta x$, has been shot out from the orifice in the time δt. Let R be the internal force that effected this; p the pressure on the jet;—then, since the only external force is Agh (neglecting Agz as extremely small),—

we have $p + R = Agh$;

and $R\delta t = A\delta x v$;

also, $Ax\delta v = p\delta t = (Agh - R)\delta t = Agh\delta t - Av\delta x$.

$\therefore Ax\frac{dv}{dt} = Agh - Av\frac{dx}{dt}$. When the motion is steady,—

$$\frac{dv}{dt} = 0, \text{ and } v = \frac{dx}{dt}.$$

$$\therefore v^2 = gh. \quad \therefore v = \sqrt{gh}.$$

This is very near to the results of experiment,—If Q be the quantity discharged in time t,—

$$Q = At\sqrt{gh}.$$

To determine the motion in a pipe of uniform bore:—

Suppose the tube inserted into a shallow reservoir of water kept constantly full; let the tube be straight, its diameter $= d$, and length $= l$; let h = height of surface in reservoir above the point of efflux. When the motion is steady, let the mean vertical velocity of the particles in the reservoir, just above the point where the tube enters, be μ times the velocity in the tube. Now, it is found that the resistance of the tube varies as the square of the velocity, and that this resistance arises from the inequalities of the interior of the tube. If, therefore, l = length of tube, and d the diameter, the absolute resistance will vary as ld; but the mass of fluid varies as ld^2.

Let now x be the distance of any point of fluid in the pipe from the point where the pipe enters the reservoir; then, by the time that x becomes $x + \delta x$,—a mass of fluid, $\pi\delta x d^2$, has had its velocity changed from μv to v.

Therefore, if R measure the force which accomplishes this—δt the time of x becoming $x + \delta x$—we shall have

$$R\delta t = (1-\mu)\, v.\, \pi\delta x d^2;$$

$$\text{and, } \pi l d^2 \delta v = \pi g h d^2 \delta t - R\delta t - e\pi l d v^2,$$

e being a constant determined by experiment;

$$\therefore \pi l d^2 \frac{\delta v}{dt} = \pi g h d^2 - (1-\mu)\, v \frac{\delta x}{dt} \pi d^2 - e\pi l d v^2.$$

Therefore, when the motion is steady, and $\frac{dv}{dt} = o$,

$$v^2 = \frac{gh}{1 - \mu + e\frac{l}{d}} = \frac{gh}{1 + \frac{e}{(1-\mu)}\frac{l}{d}}$$

If $1 - \mu = \frac{2}{3}$, or $\mu = \frac{1}{3}$, and $\frac{e}{1-\mu} = \frac{1}{57}$ nearly, this becomes Eytelwein's formula.

If the water had first passed through a tube, length l and diameter d, and then through a tube l', diameter d', we should have had

$$v^2 = \frac{gh}{1 - \mu + e\frac{l}{d} + e\frac{l'}{d'}}.$$

Eytelwein's formula in inches is $v^2 = 23\frac{1}{2}\sqrt{\frac{h}{1 + \frac{l}{57d}}}$

Example.—Water flows through a 9-inch main of 5000 feet, and then through a pipe of 4000 feet long and 5 inches diameter, the height of head being 100 feet, what is the velocity of the discharge?

$$v = 23\tfrac{1}{2}\sqrt{\frac{h}{1 + \frac{l}{57d} + \frac{l'}{57d'}}}$$

$$l = 12 \times 5000 = 60000$$
$$l' = 12 \times 4000 = 48000$$
$$h = 12 \times 100 = 1200$$
$$d = 9 \qquad d' = 5$$
$$57d = 513 \qquad 57d' = 285$$

$$v = 23\tfrac{1}{2}\sqrt{\frac{1200}{1 + \frac{60000}{513} + \frac{48000}{285}}}$$

$= 23\frac{1}{2} \times \sqrt{4{\cdot}2}$, nearly; or 47 inches per second nearly.

We may remark that the value we have obtained for the mean velocity of the discharge at a small orifice, $\sqrt{gh}$, is rather greater than the velocity derived from experiment: this does not arise from any

fault in our hypothesis of the mean vertical velocity of the particles in the vessel being = 0, but from the resistance of the sides of the orifice. It is probable, that the mean vertical velocity just over the orifice, is some small fraction of the velocity beyond it;—this, if considered by itself, would give v something greater than $\sqrt{gh}$. But the resistance is more than sufficient to counterbalance the effect of the interior velocity: v would properly be represented by the expression $\sqrt{\frac{gh}{1-\mu+e}}$, where e is rather greater than μ.

J. H. R.

A NEW THEORY OF THE EARTH, THAT FULLY ACCOUNTS FOR MANY ASTRONOMICAL, GEOGRAPHICAL, AND GEOLOGICAL PHENOMENA, HITHERTO UNACCOUNTED FOR.

By Oliver Byrne.

Although the sciences of mathematics are coeval with man, and have been cultivated with the greatest avidity by the greatest minds of every age, in every civilised nation; although their extent and application are at present very great—considered by some to be capable of little further advance—yet it may safely be asserted that they are only in their infancy: as long as we continue to improve, so long will the bounds of mathematics continue to extend, till all other human inquiries become subject to its simple and unerring principles. The theory which is here promulgated, and which we shall endeavour to exemplify and explain in the simplest terms possible, is capable of being submitted to the most exact and rigorous mathematical scrutiny. Yet in this place we prefer establishing it by a general concurrence of facts which are known to almost every observer, rather than by an abstruse and elaborate mathematical process; because, by proceeding on the former plan, the subject will be understood by the many, while the latter, which is given in the proposer's new work "On the theory of the heavens and earth," about to be published, would only be understood by the few, who at present know enough of the uncertainty and dissatisfaction which have attended former attempts to establish the point in view by such a procedure.

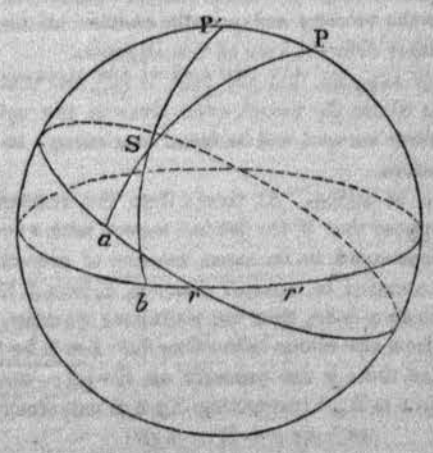
By observing the apparent motions of the fixed stars and of the sun and planets, the true motions of the bodies in our solar system were discovered,—not before the attention of man was for a considerable time engaged by their appearances and changes, and many theories respecting them advanced and confuted: but this, like other subjects capable of being submitted to mathematical investigation, was ultimately set right. The motions of the earth on its axis and round the sun were discovered in the same manner, by observing the apparent motions of the fixed stars. Seeing that all the stars rise and set in the course of a day, the stars must move round the earth, or the earth must revolve on an axis in that time: the truth of the latter motion was finally established. It was also observed that the stars which appeared to set with, or immediately after the sun, gained an advance on him till they were lost in his rays, then appeared to pass him and return to their former position with respect to the sun, in the course of a year. This fact shows either that the stars moved round the sun, which stood still, while the earth with revolving on its axis would possess a wabbling motion, or what might be called at the present day a great nutation, to effect the change of the seasons; or that the earth stood in the same position revolving on its axis, while the sun made a circuit of the heavens in the course of the year: or lastly, which was ultimately found to be true, that the sun nearly remained in the same relative position, as well as the fixed stars, and that the earth moved round him in the course of a year, and that also in such a manner, the changes of the seasons were produced.

At present here it would be useless, as well as a laborious task, to give even an outline of the several theories and conflicting opinions which have prevailed, before the true theory of the solar system was established. We regret that our present limits will not permit us to give such an outline; as it might at the same time give a caution to many not to condemn, censure, or approve, before they have investigated and understood. This theory of the earth, which likewise shows the cause of many astronomical phenomena, is not introduced and promulgated for the purpose of confuting any of the well established laws of the solar system. The great difference between what is here advanced and other theories, is that only two of the motions of the earth are admitted, namely, the annual and diurnal. The other apparent or imaginary motions known by the terms "the precession of the equinoxes," "solar and lunar nutations," and "the decrease in the obliquity of the ecliptic, or rather, the collapsing of the planes of the equator and ecliptic," are rejected; and the true cause of such apparent motions substituted in their stead, which we shall in future call the right motion or change of the earth's axis. Many, as well as those who propose anything new, be it ever so true, must be well aware of the fact, that the proposer or inventor of any new scheme, be it ever so important or useful, no matter how willing and well prepared he may be to verify his claims, even in these enlightened times, frequently struggles in vain to gain attention, much less to obtain belief: facts, it is true, are stubborn things, but prejudices are far more stubborn.

This difficulty mainly arises from the confidence of mankind being so often deceived and grossly abused by imaginary improvers and visionary inventors. However, the inventor or proposer of a new theory, who can establish his claims by strict mathematical arguments, no matter how uncommon they may at first appear, places beyond all doubt their certainty; and although he cannot induce people to study or think for themselves, yet he defies all efforts to confute one single tittle of anything which may be thus established. Before proceeding further we beg to acquaint general readers, that few technicalities are used, and those retained are explained in the simplest manner possible; this remark was considered necessary, because subjects of the like nature are too often unnecessarily encumbered with technical terms. Although this theory of the changes, nature, and form of the earth, is here established without the use of x's, y's, Greek characters, or many technical terms, the reasoning employed is strictly mathemacal; not that we object to this plan of proceeding, but that the work, as we have before observed, may be generally understood. To accommodate the profound mathematician, as well as the general reader, this theory is established by the plan objected to here in the proposed new work before alluded to.

To return to the leading principle of this theory, which is substituted for what is called "the precession of the equinoxes," "solar and lunar nutations," and "the collapsing of the planes of the equator and ecliptic," one motion, which is here termed, the right motion of the earth's axis. In the first place, we shall define or rather explain the meaning of these terms. The points where the planes of the equator and ecliptic intersect are called the equinoctial points; they have a retrograde motion, which is called the precession of the equinoxes. This apparent motion was observed long before the Christian era; it could not remain for any long time undetected, as the latitudes and longitudes, as well as the right ascensions and declinations of the stars were reckoned from one of these points,—Aries.

The declinations and right ascensions of the stars are reckoned in a manner similar to the latitudes and longitudes of places on the earth, only the first meridian is supposed to pass through the equinoctial points; this reckoning commences at the equinoctial point, Aries. The longitude is reckoned from the same point along the ecliptic, and the latitude on great circles passing through its poles.



Let P be the pole of the equinoctial $r\ a$, and P the pole of the ecliptic $r'\ r\ b$; r the first point of Aries where they intersect; and s, a star. Then $r\ a$ is called the right ascension, and $a\ s$ the declination, of that star; $r\ b$, $b\ s$, the longitude of the same, respectively. If these planes were to intersect at r', the effect would be, that the longitudes of the stars, which are always estimated from the intersection of the planes of the equinox and ecliptic, or from the first point of Aries, must continually increase; and by comparing the longitudes

of some of the stars at different times, the mean motion of the equinoctial points, or the precession of the equinoxes, may be discovered. M. Lalande, in his astronomy, has computed the precession by comparing the longitude of Spica Virginis, as assigned by Hipparchus, with the longitude of the same star computed in 1750.

128 B.C.	Longitude of Spica Virginis	5ˢ	24°	0′
1750 A.D.	Ditto	6	20	21
	Increase in 1878 years	0ˢ	26°	21′

From this it appears that the annual mean precession is equal to $50''\cdot5 = \frac{26° 21'}{1878}$. By a number of like comparisons, the same author fixed the secular precession—that is, the amount of accumulated precession for 100 years—to be 1° 23′ 34″; the mean annual precession corresponding to this is 50″·34: and the sum of such annual precession amounts to 1° in 71½ years. If we suppose the precession to be 50″·1, then, in 25,869 years $\left(\frac{360\times60\times60\times10}{501}\right)$, the first point of Aries will have retrograded through an entire circle. The quantity 50″·1, which is the mean value of the precession, is obtained from the differences of the longitudes of a great many stars (three or four hundred, for instance), computed at different epochs. This mean quantity may not agree with the mean quantity derived from the observations of a single star, however many, or accurately made, these observations may be. It will be found the case with Pollux, the second star in the following table. The differences, however, between the mean quantities of the precession as they result from three hundred stars, or from a single one, is in all cases very small.

Longitudes.

Stars.	1815.			1756.			Difference of Longitude in 59 years.		Mean Annual Increase.
	s.	°	′ ″	s.	°	′ ″	′	″	″
α Arietis	1	5	4 41	1	4	15 3	49	38	50·47
Pollux	3	20	39 48	3	19	50 55	48	53	49·70
Spica Virginis	6	21	15 31	6	20	26 20	49	11	50·10
α Aquilæ	9	29	9 53·8	9	28	20 6	49	47·8	50 80
α Pegasi	11	20	54 31	11	20	5 19	49	12	50·10

Yet the difference which is found to exist, points out some peculiarity in every star. For instance, Pollux cannot be like most of the other stars, apparently entirely fixed, but must have what is called, or what we are obliged to call, from default of a knowledge of its cause, a proper motion. However, the comparison of the longitudes of the stars, computed to the epochs of 1756 and 1815, establishes, as we have before observed, the important fact of the precession of the equinoxes. Because the mean longitude of a star is not altered solely by the precession of the equinoxes, astronomers employ the term *annual variation*, comprehending under it the effects both of *precession* and of *annual proper motion*.

We shall now compare the latitudes of the stars mentioned in the above table, at the same epochs.

Latitudes.

Stars.	1815.			1756.			Difference for 59 years.
	°	′	″	′	″		″
α Arietis	9	57	37·4 N.	9	57	3·2	+ 5·4
Pollux	6	40	18·4 N.	6	40	3	+15·4
Spica Virginis	2	2	24·8 N.	2	2	6	+18·8
α Aquilæ	29	18	35·5 N.	29	18	44	− 8·5
α Pegasi	19	24	44· N.	19	25	44	− 4·0

It appears from this table that the changes of the latitudes are very small, in no case amounting to 0·4″ annually. "The astronomical fact is," says Woodhouse, "a minute annual change of latitude, and a considerable change of longitude. With regard to the former change, we may conjecture that it arises either partly from the precession of the equinoxes, and partly from other causes, or that it is altogether independent of the precession." The succeeding tables show the *variation* both in right ascension and declination of the stars whose latitudes and longitudes we have just compared. These variations more clearly point out the general apparent change produced in the heavens by *the right motion of the earth's axis*, than those of the latitudes and longitudes, as the declinations and right ascensions of the stars are reckoned in a manner similar to the latitudes and longitudes of places on the earth. Yet they are not in complete accordance with the *right motion*, as the latitudes of places have been supposed to remain fixed and from the dissatisfactory theory of corrections, of which we shall speak hereafter.

Right Ascensions.

Stars.	1843	1817	Difference in 26 years.	Mean annual variation.
	h. m. s.	h. m. s.	s.	
α Arietis	1 58 20·06	1 56 52·67	87·39	+ 3·36
Pollux	7 35 42·09	7 34 6·06	96·03	+ 3·69
Spica Virg.	13 16 55·80	13 15 53·79	62·01	+ 2·38
α Aquilæ	19 43 7·34	19 41 51·05	76·29	+ 2·93
α Pegasi	22 56 56·64	22 55 38·95	77·69	+ 2·98

Declinations.

Stars.	1843	1817	Difference in 26 years.	Mean annual variation.
	° ′ ″	° ′ ″	″	
α Arietis	N 22 43 4·14	N 22 35 33·1	7 31·04	+ 17· 34
Pollux	N 28 23 58·81	N 28 27 31·7	3 32·89	− 8·188
Spica Virg.	S 10 20 23·55	S 10 12 6·5	8 17·05	+ 19·117
α Aquilæ	N 8 27 26·37	N 8 23 37·6	3 48·77	+ 8·779
α Pegasi	N 14 21 41·97	N 14 13 26·0	8 15·97	+ 19·075

Of the Collapsing of the Planes of the Equator and Ecliptic.

The angle contained between the plane of the equator and ecliptic is what is denominated the obliquity of the ecliptic; which is shown, from repeated observations, to be variable. In this place it will be sufficient to show the results of a long succession of such observations by different astronomers, taken from the "Encyclopedia Metropolitana":—

Eratosthenes,	230	B.C.,	made the obliquity to be	23°	51′	20″
Hipparchus,	140	„	„	23	51	20
Ptolemy,	140	A.D.	„	23	51	10
Pappus,	390	„	„	23	30	0
Albatenius,	880	„	„	23	35	40
Arazachel,	1070	„	„	23	34	0
Prophatius,	1300	„	„	23	32	0
Regiomontanus	1460	„	„	23	30	0
Waltherus,	1490	„	„	23	29	47
Copernicus,	1500	„	„	23	28	24
Tycho,	1587	„	„	23	29	30
Cassini, sen.,	1656	„	„	23	29	2
Cassini, jun.,	1672	„	„	23	28	54
Flamstead,	1690	„	„	23	28	48
De la Caille,	1750	„	„	23	28	19
Bradley,	1750	„	„	23	28	18
De la Lande,	1768	„	„	23	28	0
Pond,	1816	„	„	23	27	50
"Oliver Byrne,"	1843	„	„	23	27	34

The observations of Albatenius and Arazachel are here corrected for refraction: those of Waltherus, De la Caille, De la Lande, computed. The obliquity of Tycho is put down as correctly computed from his observations; also the obliquity as determined by Flamstead, is corrected for the nutation of the earth's axis: these corrections Lalande applied. It is manifest, from the above observations, that the obliquity of the ecliptic continually decreases; and the "irregularity which here appears," says the writer, "in the diminution, we may ascribe to the inaccuracy of the ancient observations, as we know they are subject to greater errors than the irregularity of this variation. If we compare the first and last observations, they give a diminution of 70″ in 100 years. If we compare the observations of Lalande with that of Tycho, it gives 45″. The same compared with Flamstead gives 50″. If we compare that of Dr. Maskelyne with Dr. Bradley's and Meyer's, it gives 50″. The comparison of Dr. Maskelyne's with that of Lalande, which he took as the mean of several results, gives 50″, as determined from the most accurate observations. The observations of Pond, compared with those of Bradley, give 44″ for the variation of the obliquity in 100 years, or 0·44″ annually."

Of Solar and Lunar Nutation.

(See "Woodhouse's Astronomy," page 353, chap. xv.)

The two inequalities that give title to the present subject are immediately, or rather intimately, connected with that of the preceding (on the precession of the equinoxes). Woodhouse says,—"For the purpose of pointing out the connexion, we must look at the physical causes of these inequalities; and, in the inequable action of the cause of precession, we shall be able to trace the cause of solar and lunar nutations." The actions of the sun and moon on the excess of the earth—which Woodhouse assumes to be "an oblate spheroid, above the greatest inscribed sphere,"—produce the retrogradation of the equinoctial points, or, as it is technically called, the precession of the equinoxes. The natural circumstances in the production of these phenomena are—the excess of the matter just spoken of. The other circumstances, scarcely less material, and indeed essential to the phenomena, are—the inclination of the sun's orbit to the equator, and the inclination of the moon's orbit to that of the sun's, and, consequently, to the earth's equator. If the sun and moon were constantly in the plane of the equator, there would, notwithstanding the earth's spheroidical form, be no precession. When either luminary is on the equator, its action in producing precession is nothing. Twice a year, therefore—namely, at the two equinoxes—the sun's force in causing precession is nothing; and twice a year—namely, at the solstices—it is the greatest. It must, therefore, be of some mean value in the intermediate times. The retrogradation, therefore, of the equinoctial points, inasmuch as it arises from the sun, cannot be equable, since the cause producing it on no two successive days of the year is exactly the same. There arises, therefore, an inequality of precession. In consequence of such inequality, the precession in right ascension of α Arietis (taking one of the instances mentioned in Woodhouse's 14th Chapter, p. 352) on May 20th, will not bear that proportion to the annual precession (3·34″) which the number of days between January 1 and May 20 bears to 365 days; and generally the precession for 50 days, whether it be in right ascension or in north polar distance, will not be necessarily equal to $\frac{50}{365} \times P$, p representing the precession. The exact portion of the annual precession (in right ascension or north polar distance) to which it is equal, or the correction necessary to be made to the mean portion, will depend on the season of the year to which the 50 days belong. The precession, therefore, after being used as a correction itself, requires to be corrected. This, however, is easily effected by altering the number by which (see p. 349, "Woodhouse's Astronomy") it is necessary to multiply the annual precession, in order to obtain its proportional part. Thus, of the star Serpentis, the annual precession in right ascension of which is 2·935″, the mean proportional precession on April 30th would be $\frac{120}{365} \times 2{\cdot}935 = {\cdot}328 \times 2{\cdot}935$, and 328 would be the multiplier: but this is too large, the actual precession generated from January 1st to April 30th being less than the proportional part of the mean. It may be made duly less by merely lessening the multiplier, ·328: in the present instance, it would be reduced to ·300, which number, and like numbers in like instances, are furnished by proper tables (see "Woollaston's Fasciculus," Appendix, page 42). This, however, it is to be noted, is not the sole method for correcting the precession. The inequable retrogradation of the equinoctial points, or the inequality of the precession, is not the sole effect produced by the unequal action of the sun on the earth's excess of matter above its greatest "inscribed sphere. The obliquity of the ecliptic, which, were the precession uniform, would not be affected by the cause producing precession, is subject to a semi-annual equation: since, as in the inequality of precession, the force causing a change in the obliquity arrives twice in a year to its maximum. Thence two effects, one an inequality of precession, the other an oscillation of the plane of the equator, constitute what is called the solar nutation." "There is also, as it may be conjectured from the arguments just alleged, a lunar nutation. The precession of the equinoxes is produced by the joint action of the sun and moon. As the sun not being in the equator, causes that part of the precession which is due to his action to be inequably generated, so the moon, continually altering her declination, is continually causing precession with an unequal force. But the period of the inequality of its action, from an evanescent state to a state of maximum, is different from the period of inequality of the sun's action. It is no semi-annual period. The lunar period depends, however, on principles the same as those that regulate the solar. When the moon's orbit, which is continually changing its position, returns at the end of any interval, to the same position which it had at the beginning, the interval so circumstanced is the period required. Now, this is regulated by the motion of the moon's nodes. The moon's orbit is inclined to the ecliptic, and its nodes retrogade in about 18 years and 7 months. At the beginning, suppose the moon's node to have been in the node of the equator and ecliptic; then, at the end of 18 years and 7 months, the same node will have described 360 degrees contrary to the order of the signs, and returned to the first point of Aries; and during this retrogradation of the node, the lunar orbit will have occupied every position which it can occupy relative to the equator. The inequality of the moon's action, then, in causing precession, will have passed through all its vicissitudes. But, as in the former case, this is not the sole effect of the inequality of the moon's force. The plane of the equator will be made to oscillate: so that, according to the longitude of the node of the moon's orbit, it will be necessary to correct the mean obliquity on account of lunar nutation." Woodhouse continues to say, in reference to another part of his book,—"We have seen, in pp. 192, 193, that the phenomena of the precession can be accounted for, by supposing the pole of the equator to describe uniformly a small circle round the pole of the ecliptic in a period of 25·869 years. But these new phenomena of precession render some modifications necessary in the preceding hypothesis. By reason of the solar nutation, the pole of the equator will oscillate during half a year about its mean place in the above-mentioned small circle, and the retrogradation of the pole will not be uniform. There will be a like oscillation, and a like inequality of precession, from the lunar nutation, but for a longer period. From both causes, then, the north polar distance, and the right ascension of the stars will be changed. In order to make the former the true precession, we must correct them both for solar and lunar nutation."

We have in the preceding pages described the cause of solar and lunar nutations. But lunar nutation, which is by far the most considerable, was not found out from a previous persuasion or belief of the existence of its cause. Bradley, soon after the discovery of aberration of light, noticed it as a phenomenon, and then assigned its cause, and the laws of its variation. But the solar nutation has never appeared to astronomers as a phenomenon. It could scarcely be expected to be noticed as such, since its maximum is less than half a second. Its existence and quantity are derived from physical astronomy; and on such authority, it is introduced as a correction of astronomical observations." Woodhouse concludes this account by saying—"It has been proved, in confirmation of Bradley's conjecture, that the phenomena of nutation are explicable on the hypothesis of the pole of the earth describing round its mean place (that place which it would hold in the small circle described round the pole of the ecliptic, were there no inequality of precession,) an ellipse, in a period equal to the revolution of the moon's nodes. The major axis of the ellipse is situated in the solstitial colure and equal to 19″·296: it bears that proportion to the minor (such are the results of theory) which the cosine of obliquity bears to the cosine of twice the obliquity: consequently, the minor axis will be 14″·364. These are M. Zach's numbers; Bradley's are 18″·16; Maskelyne's, 19″·10; Laplace's, 19″·16 (see 'Mecanique Celeste,' lib. v., p. 351)." Now, *the right motion, or change of the earth's axis*, is effected by the combined actions of the sun and moon on the excess of the earth over its greatest inscribed sphere, which excess will be shown hereafter to be in a continual state of change. Former theorists ascribe to this influence of the sun and moon, upon the excess above mentioned, the effects which we have just summed up from "Woodhouse's Astronomy" and the "Encyclopædia Metropolitana,"—namely, "The precession of the equinoxes," "Solar and lunar nutation," and "The collapsing of the planes of the equator and ecliptic." Here there is but one effect ascribed to this combined action of the sun and moon.

(To be concluded in our next.)

[As far as we can understand the purport of the above paper, it is to show that the variation of the angle of the obliquity is not oscillatory, as has hitherto been supposed, and partially demonstrated by some of the most eminent of modern mathematicians. We trust Mr. Byrne will in the next number favour us with his analysis, and justify the view he has taken of the subject.]—EDITOR.

ON THE COMBINATION OF THE TELESCOPE WITH THE DAGUERREOTYPE.

(*From the Transactions of the Royal Society of Bohemia*, 1846.)

Professor Doppler, of Prague, says, that for the ascertaining of the diameters of fixed stars, the telescope has been hitherto mainly depended upon, and that the instrument has been so far improved as it possibly ever can and will. The susceptibility of the human eye for the minutest objects has been hitherto considered paramount; but M. Doppler asserts, that the susceptibility of the human retina is surpassed many thousand times by that of a prepared (iodized) Daguerreotype plate. Physiological experiments have shown, that objects, which appear to us under an angle of vision *less* than 50 or 40 inches, are no more seen *in extenso*, but as *amorphous* simple points. On the other hand, physiological researches of such men as Müller, Weber, &c., have shown, that the diameter of one of the nerve-papillæ of the retina is no more than $\frac{1}{4000}$ or $\frac{1}{3000}$ of an inch. But, comparing the susceptibility of the retina papillæ with the microscopic experiments made with Daguerre's plates, it will follow that the single globules of mercury are of such extreme minuteness, that they become only visible by a 800-fold magnifying power; and, therefore, that on the space of a Daguerre plate, equal to one retina papilla, more than 40,000 single minute globules of precipitated mercury are to be met with. Each of these is capable of producing the image of well defined objects—which would merge on the human retina in single, indiscernible luminary points. Thence, Prof. Doppler argues, that Daguerre's plates are 40,000 times more susceptible for impressions than the human eye.

Considering, moreover, that a great improvement in microscopes is very probable, M. Daguerre thinks that instead of telescopes,—microscopes will come into use. At the exact point, therefore, where the image of a celestial body is formed before the object-lens of a telescope of considerable length, an apparatus is to be placed, whereby a silver plate (iodized, brome-iodized, or otherwise prepared) can be securely inserted. As the place of the images is the same for all celestial objects, a plate of a well defined, constant thickness, can be inserted with great accuracy. In this way, Daguerreotype images of all, even of the smallest, fixed stars can be obtained, if (as is to be supposed) the light will be sufficient to affect the plates. It is also to be taken into account, that the images of the fixed stars, obtained by an object-lens of from 10 to 12 inches, will possess a light, 10,000 times stronger than they present to the naked eye. Plates thus affected, are to be treated with mercurial vapours and laved (*lavirt ?*), and then viewed by a good microscope. As these images will have been magnified (through the action of an object-lens—say of 110 inches focus length) to the extent of 14 times their natural appearance; and being again magnified 1,200-fold,—the angle of vision under which they are now to be viewed, will have been increased 16,800-fold.

J. L——r.

REVIEWS.

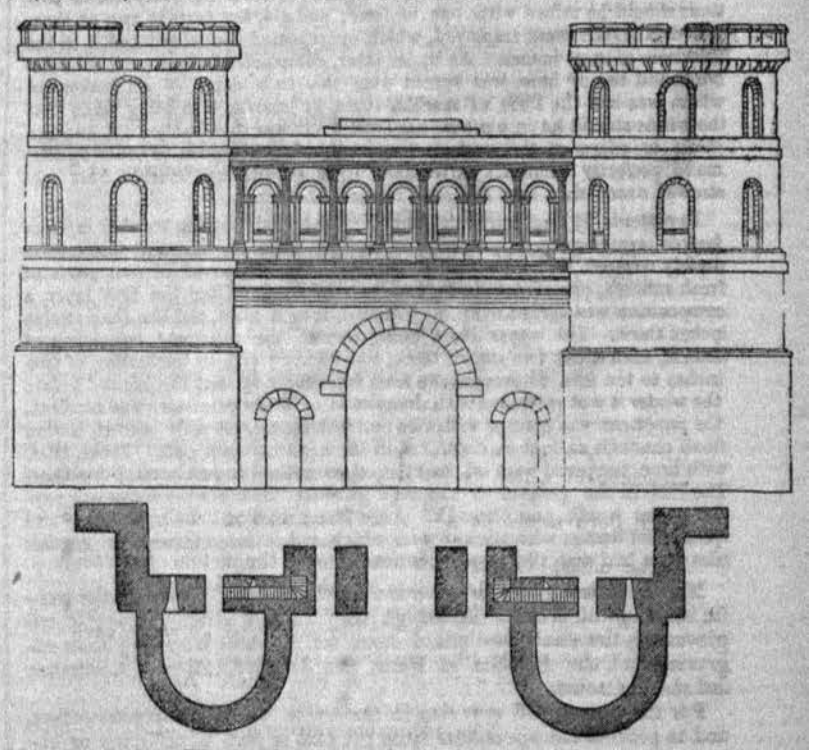
Encyclopædia of Civil Engineering,—Historical, Theoretical, and Practical. By EDWARD CRESY. Royal 8vo. London: Longman and Co. 1847.

Mr. Cresy's long expected Encyclopædia of Engineering has at length made its appearance, much to the credit of its indefatigable and talented author, who after three years of compilation has produced a work which forms a vast octavo volume, consisting of rather more than 1600 closely printed pages, and upwards of 3000 well executed wood engravings by Branston.

The work is divided into two parts—the one entitled "The History," the other "The Theory and Practice, of Engineering." The first division might with more propriety have been termed the "History of Engineering and Architecture," as a considerable portion of it is devoted to the description of merely the external forms of edifices.

To the History of Engineering we shall for the present confine our remarks, reserving for another opportunity the consideration of the second and more practical division. From this our æra of "the railway and the steam-ship, and the thoughts that shake mankind," Mr. Cresy transports us to a period coeval with the first rude attempts of Ætheopian architecture, and starting from that point exhibits, step by step, the gradual progress of structural science. The principle of the arch, which, according to the authorities quoted in the Encyclopædia, must have been known to the early Egyptians, is lost sight of in a marvellous manner by the Greeks; its employment even by the Egyptians, seems to have been very limited. The trabeate was apparently more consonant than the arcuate style to the severity of ancient ideas of beauty. The repose, the grand simplicity, and oneness of effect of early Grecian architecture are due, mainly, to the exclusion of all curved lines and tracery, and seem to us impossible to be developed in any construction that admits the arch as a prominent feature. For our part, we believe that the contrast between the vast simple masses of ancient masonry, and the clear deep unclouded blue of an eastern sky, must have produced an effect infinitely more sublime than the most gorgeous of English arcuate cathedrals, viewed as *they* are against the clouded sky, and through the smoky medium of our dull climate. The vault of Mycenæ, to which reference has been made in a former number, is a curious instance of the form, without the properties, of the arch.

From Grecian, Mr. Cresy conducts us to Roman architecture, a division of the work containing some highly interesting information, of which we shall proceed to give an analysis. It commences with an account of the walls, towers, and other military defences of the important city of Rome: we have engravings of the wall of Sevrus Tullius, which surrounded the entire city; the bold severity of the outline, the battering of the lower portion of the wall, and the capping formed by an embattlement, show at once its object—that of a defensive boundary;—next we have the Aurelian Wall and Gate of St. Paul, then the Gate of Spello, of Aosta, approaching in design to our Norman style of architecture. The Gate of Perugia is another example of an early gate, marked by the boldness of its outline. The Gate of Augustus, at Fano, is of a more ornamental character:—



THE GATE OF AUGUSTUS AT FANO.

"The lower portions of which are of great antiquity. Fanum Fortunæ was the name the city formerly bore, which, from its sumptuous buildings, was greatly admired. There are three entrances, flanked by circular towers, which rise to a considerable height, the two upper stories being lighted by semicircular-headed openings, and crowned with a bold projecting cornice, over which is the battlement. Immediately over the three entrances was a gallery, formed by seven arches, between Corinthian pilasters, and surmounted by a regular entablature. The repairs these walls underwent during the reign of Constantine somewhat changed their character, and since that period the upper story was destroyed by a cannonading which took place when this town opposed Julius II. Various inscriptions remain amid the several works of restoration."

and lastly, we have the Gate of Autun, one of a triumphal character.

The work then proceeds describing the materials used in the edifices of Rome. Burnt bricks came into general use for public buildings about the time of Augustus, when they were made less than an inch in thickness, of a triangular shape; sometimes the brickwork was formed of a mixture of red and yellow brick; at a later period a mixed construction was formed of brick and tufa, as in Caralla's circus. With the decline of Roman institutions, we are told that the art of construction lost its excellence, and that no care was taken in the selection of

the materials. Various descriptions of stones were used,—the tufa of a reddish hue, and of a volcanic production, much used for the interior of walls, and in reticulated and rubble walls;—pepperino, another stone much used, also of volcanic production, but harder, and resisting the action of fire and the weather better than the tufa;—and the travertine, a stone much used in public edifices, calcareous, hard, and of a yellow tint. The most ancient edifices of Rome were constructed of Albano stone, put together in squared blocks and united by metal cramps; it was also used in conjunction with the travertine stone, which from its greater hardness was used in those parts of an edifice most liable to injury, as arches, architraves, cornices, &c. Marble of various countries was also largely introduced in the public edifices of Rome. The Romans devoted much attention to pavements, which—

"When used for floors, were highly decorated, much attention being required to prepare the soil to receive them, and to select the material of which they were formed. When on the ground, it was carefully examined, and rendered solid throughout, after which it was spread over with some dry material. When laid upon a timber floor, walls were not built under it, but a space left between it and the floor, that the drying and settling should be equal throughout. Holm timber was preferred to oak, being less likely to split and warp, and thus cause cracks. After the joists were laid, thin boards were fastened down to them by two nails, driven through the edges of each, which prevented their rising. Fern or straw was then spread over the whole, to prevent the lime coming in contact with the timber, which would have immediately caused it to decay. Over this was a layer of rubbish, the stones of which were as large as would lie in a man's hand: on this layer the pavement was afterwards laid. New rubbish required that every three portions should be mixed with one of lime; and old, five parts to two of lime. Wooden beaters were employed, which by repeated blows reduced it to the thickness of nine inches. An upper layer, composed of three parts of potsherds and one of lime, was spread over this to a depth of six inches, on which was laid the slabs of marble, stone, or tesseræ, care being taken that the whole should lie in a proper inclination: it was then rubbed off, and the joints or edges of the ovals, triangles, squares, hexagons, or other figures, made perfectly smooth. After rubbing and polishing, marble dust was strewed over; then lime and sand run into the joints.

Pavements in the open air had over the first flooring another layer of boards crossing them, properly secured by nails, so that the joists were doubly covered. The pavement first laid was composed of two parts of fresh rubbish, one of potsherds, and two of lime. After the first layer, a composition was spread over it, pounded into a mass, not less than twelve inches thick. The upper layer being spread, the pavement, consisting of tesseræ, each about two inches thick, was laid on, with an inclination of two inches to ten feet, to prevent the frost from injuring it at the joints: before the winter it was saturated with dregs of oil. When great care was required, the pavement was covered with tiles two feet square, properly jointed, having small channels an inch in depth cut in the edge on each side. These, filled with lime, tempered with oil, had the edges rubbed in and pressed together. The lime in the grooves or channels growing hard, neither water nor anything else would pass through. After this precaution, the upper layer was spread and beaten with sticks; over which, either large tesseræ or angular tiles were laid with the proper inclination."

Mr. Cresy has given us some architectural descriptions of the public buildings of Rome. Although they do not strictly belong to engineering, the examples afford data for construction;—we have engravings of the Basilica at Fano, the Amphitheatres of Castreuse and the Coliseum.

For the purpose of covering in the arena of these amphitheatres, and to protect the spectators from the rain or sun, a *velarium* or covering was used:—

"Lampridius (in Com. a Militibus, Classiariis) informs us that the management of the vela was left entirely to sailors, as they were more expert in going aloft amidst ropes, and understood the tackle which regulated the spreading of it better than others. There can be no doubt that it required considerable dexterity on the part of the engineer to keep steady an awning containing 113,345 superficial feet, which would be required for the amphitheatre at Nismes, and for the magnificent Coliseum nearly 250,000 superficial feet, or more than double; the weight of which, at only one pound per foot, comprising the ropes and tackle, would amount to 112 tons or thereabouts. So vast a weight disposed and upheld by tension alone creates our wonder and admiration.

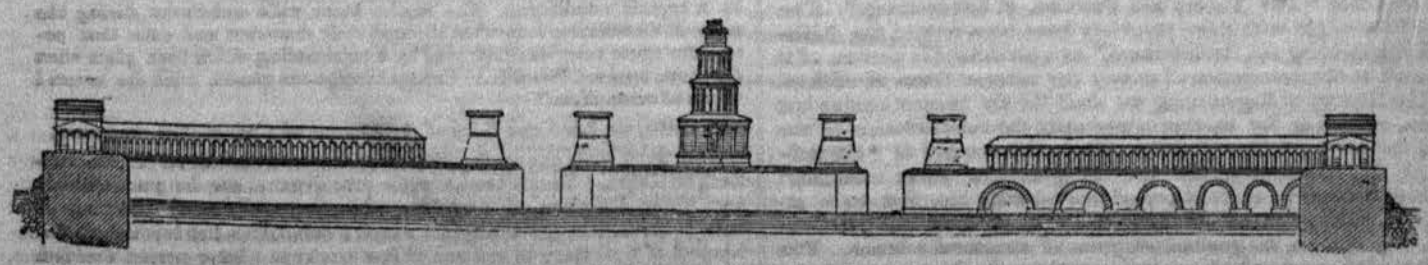
At the level of the attic story are 120 projecting consoles, each having a circular hole about 10 inches in diameter, corresponding with a circular mortice of the same size, and 6 inches in depth, made in the projection of the cornice of the second order. The upper opening of the hole in each console has externally a groove 2 inches in height, destined for an iron collar, to which was attached a tie, which secured it to the wall of the attic at the level of the top of the console: the holes which contained these have some portions of the iron run with lead remaining.

The whole of each console received a round mast, which, passing through it rested in a hole sunk in the cornice below, the iron collar preventing it from acting against the sides of the console and fracturing it. The masts alone would not be sufficient to support the weight of the vela, extending over an elliptical area, the axis of which, in one direction, was 436 feet, and in the other, 331. To aid in the support, other posts were introduced through mortices about 10 inches in length, placed opposite each console, at the projecting part of the moulding which crowns the interior of the attic; on each side, 4 or 5 inches from the edge of the attic, are holes still containing the lead which secured the iron ties that held these latter posts in their places. Under the mortice holes are others, 8 inches square, and 2 feet in depth, made in the upper step of the attic to receive the second posts. The two posts were afterwards securely braced.

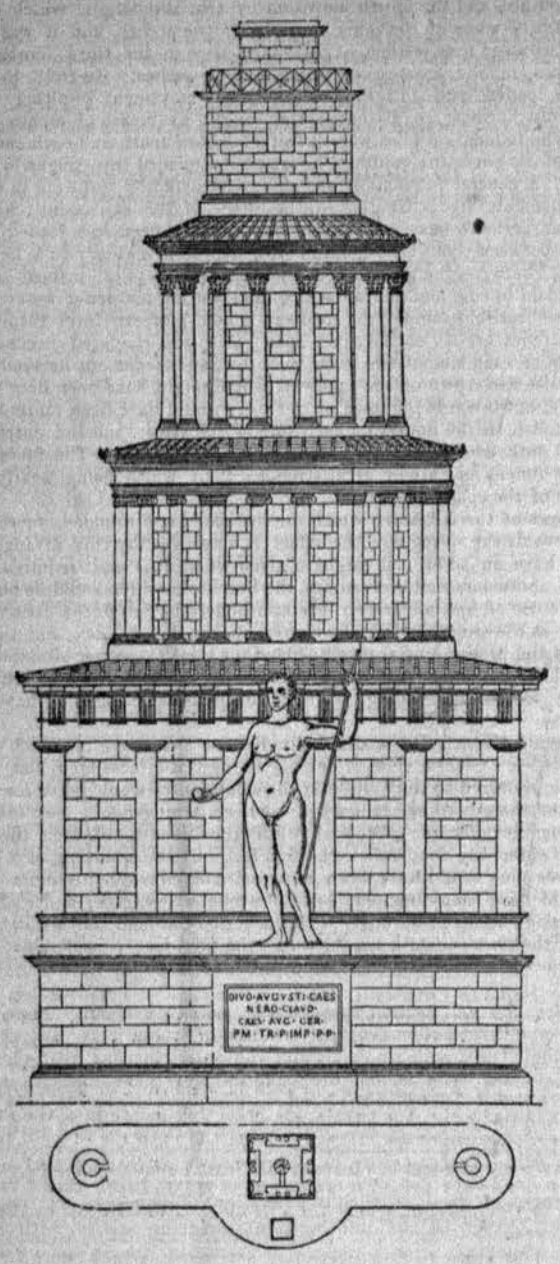
Over the centre of the arena was an oval covering, permanently fixed, which in the Coliseum was ornamented with an immense golden eagle. Round the edge of this oval covering was attached a large cable. 120 pair of cords, of equal length, stretched from the masts on the exterior to this cable, were worked by pulleys; thus forming as many compartments. Each pair of cords was furnished with rings, to which the covering was attached, so that it could be drawn backwards and forwards at pleasure. The whole of these were called the vela or velaria, and each single compartment velarium. The distance between the ropes on which the velarium ran was greater towards the attic than at the centre; consequently, to make the velarium run freely on its rings, it was necessary that it should be of an equal width throughout: when spread, towards the attic it was stretched, whilst towards the centre it sagged, and formed as it were a fold. To prevent the sun passing through the opening thus made by the sagging, an internal hanging was attached around the fixed permanent oval."

The Romans devoted great attention to the construction of baths which were generally used by all classes of citizens. At one time, there were more than 800 baths in Rome; the most complete contained six principal apartments,—1st. *The Apodyterium*, for undressing; 2nd. *The Frigidarium*, or cold bath; 3rd. *The Tepidarium*, used to prevent, by the temperate air which it contained, the dangerous effects of too sudden a transition from the extreme of cold to that of heat; 4th. *The Laconium*, an apartment warmed by a stove, to send forth a dry heat; 5th. *The Balneum*, or warm bath; 6th. *The Eleothesium*, or *Onctuarium*, where the oils and perfumes used by the bathers were kept.

We now come to that portion of the work which may be strictly considered as connected with engineering—harbours and buildings in water. It will be seen by the construction of these works that the Romans devoted vast talent to their formation and construction. In our Journal for January last, we gave a highly interesting paper on the Harbour of Ostia near Rome, by Sir John Rennie, together with a plan of the harbour. We are now, through the labours of Mr. Cresy, enabled to give engravings showing a section through Claudius' Port, and the elaborate Pharos.



SECTION THROUGH CLAUDIUS' PORT, OSTIA.



PHAROS, AT OSTIA.

"The port constructed by Claudius, in advance of that of Trajan, was amongst the boldest executed by Roman engineers:—an oval sheet of water, enclosed from the ocean by broad and spacious moles, affording a safe haven for vessels which navigated the western shores of Italy: an artificial island lay between the horns of these two moles, with towers at each extremity, containing machinery and tackle of various kinds, by which the boatmen could at all times enter safely. These constructions must have been a work of prodigious labour; their solidity is attested by the writers of the time, particularly by Pliny. In the middle of this island stood a pharos, before which was the colossal statue of the emperor Claudius. Fire was placed, at the approach of night, in the upper story of this lofty structure, which could be seen from a considerable distance. Orders of the purest architecture decorated three of the stories, and ingeniously-contrived rooms and staircases served for the use of the officers and men to whom this part of the port was entrusted. Covered galleries and porticoes standing high above the sea, and stretching far into the ocean, invited mariners to enter, and produced an imposing effect to all who navigated these seas.

The port of Claudius united to that of Trajan gives us an idea of the arrangements in use during the reign of these emperors; magazines for stores of all kinds, docks, slips, and other buildings usually found in a modern port, were here executed in a manner equal to those of the imperial city. Temples, triumphal arches, rostral columns, and trophies, occupied the spaces not used by the mariners, and noble roads conducted the merchandise and warlike stores from thence to every part of the empire."

Descriptions and engravings are given of the harbours at Naples, Cuma, Puzzuoli, Spezzia, Genoa, Ancona, Antium, Tarentum, and Brundusium,—all of them possessing considerable interest; then follows some account of the Roman roads and the celebrated Appian way, which is succeeded by

The Bridges of the Romans.

These bridges are generally constructed with semicircular arches of stone of the hardest quality; they were remarkably solid and well proportioned, and formed fine specimens of Roman architecture as applied to bridge building;—the Ponte Sisto and Bridge of St. Angelo are two fine examples. The bridge and aqueduct of Spoleto consisted of 10 Gothic arches, 70 ft. 3 in. span; the centre arches stood 328 feet high above the river Moragia.—*Trajan's Bridge*, over the Danube, the most magnificent in Europe, built A.D. 120, consisted of 20 semicircular arches, 180 ft. 5 in. span; the springings were 46 feet above the river, and the piers 64 feet thick by 85 ft 3 in. wide: the stones used were enormous, but it was destroyed a short time after its construction.—The *Bridge near Terni*, on the Nera, consisted of 17 arches, 131 ft. 3 in. span, and 111 ft. 6 in. high up to the springing; the piers were 27 ft. 6 in. thick, and the total length of the bridge 2592 feet, by 32 feet wide. The dimensions of the few examples we have selected show that the Romans were quite equal to the modern engineers in the stupendous character of their works. We shall close this account with some particulars of the *Bridge of the Trinity*,—one of more recent date. (See Engraving, *Plate* VIII.)

"The Bridge of the Trinity, at Florence, was constructed in 1750, by Ammanati, a celebrated architect. This bold work consists of three arches, nearly elliptical, the curve being portions of two parabolic arches, whose angle at the top is masked by an escutcheon. The span of the arches is from 87 feet 7 inches to 95 feet 10 inches; the springings are 7 feet 10 inches above low water, and the rise is one-sixth of the span; the arches are 3 feet 2 inches thick. The breadth of the piers is 26 feet 3 inches, and that of the bridge 33 feet 9 inches. The facings of the piers are worked stone, with well executed mouldings. The other parts of the structure are of rubble; the foundations rest on a general framework, surrounded and crossed by several rows of piles. A defect which occurred under one of the piers of the bridge was repaired in 1811 by the elder Goury."

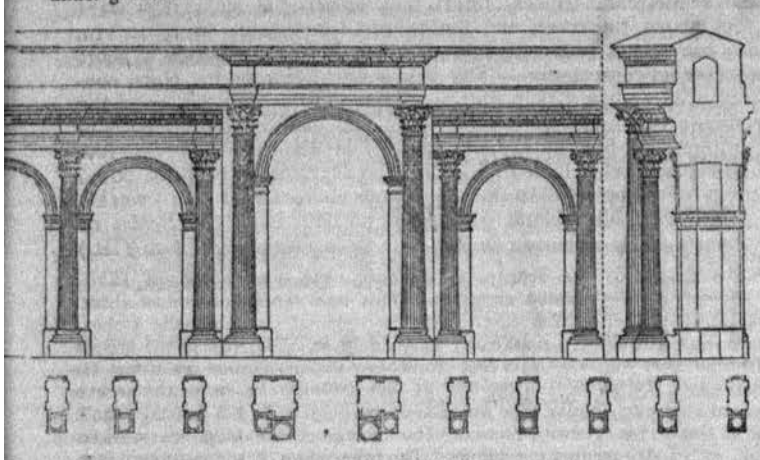
The architectural character of the Bridge of the Trinity at Florence is particularly worthy of attention, because it is a rare instance of pure arcuate construction, executed subsequently to the decay of Pointed architecture. The "Revival" (or as it ought to be called the "Ruin") of architecture had no more hideous or conspicuous characteristic than that of sticking upon arches ornaments of a totally inappropriate character. The taste which promoted this fashion was precisely that of the Indian squaw or African savage, who stick bits of finery in their ears and nostrils. The Florence bridge, however, is singularly free from these faults, though erected at a period when the subservience of decoration to construction was utterly disregarded—it has not the slightest vestige of trabeate construction.

Except in the Pointed period, this merit is extremely rare. Previously to that period the Romans, and subsequently to it the Revivalists, treated the arch as a thing to be ashamed of. They endeavoured to disguise its real character as much as possible,—absurdly overloading it wth the forms of Greek temple-architecture, and producing a nonsensical combination which would appear irresistibly ludicrous, had not a multitude of examples familiarised our eyes to the incongruity. Let the reader compare Blackfriars or Waterloo Bridges, with their foolish unmeaning columns, with this Bridge at Florence or London Bridge; and then, if he can so far overcome the prejudices of education, ask himself which is the purer and more sensible architectural design.

We now come to a very interesting portion of Roman engineering—that is, the supply of water. The Romans devoted great zeal and attention to the obtaining of a good supply of pure and wholesome water,—not like the Londoners, who are content with obtaining their supply from the polluted river, because the whole district of the metropolis is under a monopolising combination.

The supply of Rome with water required seven aqueducts, until the time of Caligula, when two others were commenced. The most remarkable were, the *Aqua Julia* and the *Tepula*, the length of the two being 17,126 paces, 7,000 of which were above ground, and 6,472 on arches.—The *Anio Vetus*, length 43,000 paces, 221 of which were subterranean, to convey the water from the Anio, above Tivoli; at a subsequent period, the water was brought from the river at a greater distance, 20 miles beyond Tivoli, for the purpose of obtaining the water of the Anio in a purer state; the length of this last aqueduct was 61,710 paces, 7,463 being above ground, and the remainder subterranean.—The *Aqua Appia*, the first aqueduct constructed in Rome, was 11,190 paces in length; the whole, excepting 60 paces, was carried underground and arched over.—The *Aqua Virgo*, 14,105 paces in length,—12,865 underground, the remainder above, on 700 arches.

"The arches which decorate some portion of this aqueduct are not only well proportioned, but receive further embellishment from a regular order of Corinthian columns: where the passage is preserved through the line, the elevation is increased by an additional height. The section at the side shows the channel for the stream, which flowed in the attic, built above the order, covered in by a vault carefully worked and well tied together: here every precaution seems to have been taken to guard against leakage, which, if it ever happened, would be immediately discovered, by the pouring out of the water at the defective place; and along the whole line of aqueduct, materials were deposited, that there might be no delay in the work; there would be also less to perform than to take up a whole length of mains laid under a solid and hard pavement, rendered impassable during the progress. Such an inconvenience in crowded streets, the Romans wisely avoided, and continued to prefer the system of raised aqueducts to those buried in vaults under ground."



AQUA VIRGINE.

The engravings of this viaduct, and also of the Gate of Augustus, at Fano, show a combination of the Trabeate and Arcuate architecture, so much adopted by the Romans; although it is highly ornate, the combination of the two do not appear to form one construction:—the Trabeate looks like an accessory to the Arcuate, and put up after the latter had been erected. This barbarism of attaching idle, unmeaning columns and entablatures to useful, effective arches, is compared by Hope, in his Architectural Essay, to the barbarous treatment of his subjects by the tyrant Mezentius, who tied living men to dead corpses. Many a modern architect would do well to think over this comparison.

Drainage was also well understood by the Romans, as may be shown by the great drainage of the Pontine Marshes, 26 miles in length, and the Cloaca Maxima, a sewer 14 feet in width and 32 feet high, for the drainage of the Imperial City. The drainage of the lakes Albano and Fucino may vie with any of our modern works.

We must, however, abruptly terminate our extracts from Rome, or we shall trespass too far for the length of our review; and proceed at once to France. It is necessary, however, to make the preliminary remark, that Holland and Germany are briefly dismissed in two pages, without a single illustration: this conciseness is to be regretted, as those countries afford some noble examples of engineering; particularly Holland, in its canals, sea walls, and works of drainage.

ENGINEERING IN FRANCE is very fully noticed, with ample illustrations. Mr. Cresy has availed himself of the numerous treatises on engineering which form so valuable a portion of French scientific literature;—he has given detailed accounts of all the principal ports and harbours of France. The description of the celebrated breakwater at Cherbourgh, formed by truncated timber cones, 150 feet diameter at bottom, 60 feet at top, and 70 feet high, is highly interesting. The lighthouses and canals are next given, and are followed by engravings of numerous bridges erected in France, one of which we have selected as a good specimen of French bridge-building:—

"The Bridge of Sevres, over the Seine, on the road from Paris to Versailles, was designed by M. Becquey de Beaupre, and executed by M. Vigoureux; it was finished in 1820, and consists of nine principal semicircular arches, 59 feet in span, and two lesser 16 feet 4 inches in span for the towing path. The thickness of the piers is 11 feet 5 inches; the width of the bridge 42 feet 7 inches. It occupies the situation of an old wooden bridge, and the axis is in the direction of the dome of the Invalides. The piers were founded by means of caissons. The arches were constructed on trussed centres, which did not change their form during the placing of the voussoirs.

All the arches were keyed in July, 1815, except the first on the right bank, where there still remained fourteen courses of voussoirs to place, when orders were given to break down the bridge, and the centre of this arch was first set on fire, and the fourth blown up by two discharges, which caused the rupture of some of the inner voussoirs of the arches, and it was afterwards discovered that settlement had taken place in the third, fourth, fifth, and sixth piers, the greatest of which was 2⅜ inches. In 1818, the sixth pier was loaded with 112 tons, without any movement resulting; it was thought fit, however, to discharge the weight by means of arches in the piers. The foundation piles were 3 feet 11 inches apart, and each carried a weight of 52 tons; the voidings, however, diminished this weight by about 5½ tons. A general foundation was also constructed by throwing in rubble. The settlements are attributed to the effect of the explosions; but they would not, perhaps, have taken place had the piles been less loaded, or the intervals between them been filled in with hydraulic masonry to a height of 6 or 8 feet between the ground and the tops of the piles, instead of with masonry laid in common mortar, which does not harden under water.

In this beautiful example, the roadway is kept perfectly level throughout, and the arches are all of the same span; this was rendered necessary, as the banks on each side of the river were low, and it was not deemed advisable to raise the crown of the roadway, which might have been done on the Paris side, but towards the town of Sevres it would have been more difficult to accomplish, as the houses on each side of the street, and the entrance to the royal park, would have been equally inconvenienced. The piers, all of the same dimensions, are of great strength, their width being nearly equal to a fifth of the span of the arch.

The faces of the voussoirs, which are rusticated and rounded, increase in depth towards the springing; the effect is improved by this arrangement, and we have an additional strength given where it is most required. For the piers, abutments, and arch stones, the best stone which could be obtained was made use of, and apparently the atmosphere has produced little change upon it: as the stones laid in the quarry, so are they bedded, and their dimensions and proportions are well defined for their respective situations. In the spandrils and wing-walls, there does not appear to have been sufficient attention paid to the backing, and inferior material is said to have been used.

This bridge, which has a decidedly Roman character, of which fig. 1, Plate VIII., is a general view, is one of the best where semicircular arches have been preferred to the elliptical; the same centre would serve for all the arches, and there is some economy in such an arrangement; but the piers occupy together upwards of 90 feet, while the breadth between the abutments or water-way does not exceed 622 feet: by the adoption of a flatter arch, fewer piers would have been required, and consequently more water-way would have been obtained: but the whole is deservedly much admired, and its design seems in harmony with the scenery around, and with the character of the river: over a stream where the tide rose considerably, or the navigation was more important, a bolder design might have been introduced.

The elevation and section through the piers (figs. 2 and 3. Plate VIII.) show its solid construction, and the form also of its starlings: over the arch are well contrived drains, which lead off the waters that fall upon the roadway, and conduct them behind the spandrils into the stream below: the blocking course, which forms the parapet, is supported upon a bold block cornice; and the absence of all balustrade and railing greatly adds to the effect of the structure. The roadway is paved throughout, and at the sides beyond the water-channel is a footway laid with a gentle inclination."

The works of the United States occupy a few pages, but no illustrations are given of the numerous engineering works with which America abounds.

ENGINEERING IN GREAT BRITAIN next occupies a considerable portion of the work, which we must pass over until next month, giving now only the description of London Bridge, which we may boast as being one of the finest specimens of bridge-building in the world, and one of the noblest edifices of the City of London.

"When the committee of the House of Commons had determined upon the erection of a new bridge, Mr. George Rennie, at the desire of his father the late Mr. Rennie, made the design as it is now executed; and as the country lost the services of Mr. Rennie by his death in 1821, the execution of this important undertaking devolved upon his sons, and Mr. George Rennie holding at that time a situation under the government, his brother, Sir John, who was his junior, was named the acting engineer. Messrs. Joliffe and Banks were the contractors, and the cost, including the approaches, amounted to £1,458,311 8s. 11¾d. The first pile for the cofferdam was driven on the 15th of March, 1824, and the dam was finally closed on the 1st of April the following year, and after the water had been pumped out 29 feet below low-water mark, it was found remarkably tight.

On the 27th of April the workmen commenced their excavations in a stiff blue clay, after which the sills and planking were laid ready for the foundations, which were commenced on the 15th of June: the first stone laid was a piece of Aberdeen granite, 5 feet ⅝ of an inch long, 3 ft. 6¾ in. broad, and 2 ft. 10 in. deep, containing 50 ft. 7 in. cube, and weighing 4 tons.

The cofferdam for the second pier was completed soon after, and pumped out by the 24th of August; in 1826 the foundations on the Southwark side, comprising the abutment and wing-walls, were carried up, and the second pier was commenced.

The cofferdams of the first and second piers being no longer required, a

portion of the piles were cut off on both sides, to prepare them for the support of the centres; and after the horizontal wedges were fixed on the heads of the cofferdam piles, on the 30th September the first rib was set up by means of large sheer poles and powerful hoisting tackle, and by the 10th November, the whole ten ribs were placed.

When the masonry of the second pier was sufficiently advanced, the centre, which had been framed in the Isle of Dogs, was floated up the river, and being hoisted upon a large double barge, was raised into its place by means of screws, assisted by the tide. The cofferdam of the third pier had by this time advanced, and soon afterwards that of the fourth pier, when it became necessary to provide more water-way by removing the pier between the fifth and sixth locks of the old bridge, and forming a wooden tressel frame of whole timbers for the traffic to pass. This was performed at the cost of £8000, by demolishing one half of the arch at a time, after which the pier below was taken away 4 feet below low-water mark. By the 4th of August, 1827, the first arch was completed; by the end of the year the second arch was keyed in, the foundation of the third pier completed, and that of the fourth laid. In 1821, the water being pumped out of the north abutment dam, and the excavations made, the first pile was driven on the 1st of February, and the entire foundations completed on the 1st of March following; the masonry was then carried up to the springing of the arches.

The first arch turned having now stood the entire winter, the wedges were struck 2 inches back on each side, and the crown lowered ⅝ of an inch; the wedges were driven back 4 inches on the following day, when the crown of the arch sank another half inch. On the third day they were driven back 6 inches, when the crown of the whole arch was clear, and shortly after the wedges were entirely driven back, when the soffite of the arch was accurately examined, and found to have preserved its form entire, although it had lowered 1½ inch. By this time the centres of all the other arches were placed, and the masonry considerably advanced: in 1829 and 1830 the centres of the middle, fourth, and fifth arches were shifted back, and when released of their load, the middle arch sank 2½ inches, the fourth 2¼ inches, and the fifth 1⅝ inch.

The centre arch is 152 ft. span, and rises 29 ft. 6 in. above Trinity House water mark; the arches on either side span 140 feet, and rise 27 ft. 6 in. above the same line, and the abutment arches span 130 feet each, and rise above the same line 24 ft. 6 in. The entire water-way being 692 feet, the total length of the bridge 1005 feet, its width from out to out 56 feet, and its height above low water 60 feet. The two centre piers are 24 feet in thickness, and the two others 2 feet less.

The general depth at which the foundation of the piers is laid below low water is about 29 ft. 6 in., and the total quantity of stone used in constructing the bridge and its abutments was 120,000 tons; the number of piles of 20 feet in length under the piers and their abutments was 2092, and the total number for the cofferdams 7708. There were four sets of timber centres, each weighing on an average 800 tons. The amount of Messrs. Joliffe and Bank's estimate for the bridge alone, including an extra set of centres, was only £425,081, 9s. 2d. The bridge was opened to the public on the 1st of August, 1831, with great pomp, after having been in progress seven years and three months.'

The engravings are accompanied by the contract specification, from which we make the following extracts (See Plate VIII.):—

The cofferdams of the abutments were of a circular form, and those of the piers of an elliptical form, as shown in fig. 5, Plate VIII, composed of two rows of Baltic timber piles, not less than 12½ inches square, five feet apart, connected together by three rows of double whole timber waleings; the top of the piles 5 feet above Trinity House water mark; there was also a third row of piles placed 6 feet from the second row; the heads were level with half tides, or 7 feet below Trinity House water mark; the spaces between the piling was filled with tough, well beaten clay, thoroughly puddled; the piling, it will be seen by the engraving, was well secured by diagonal struts, besides wrought iron tie-bolts.

Foundation (Fig. 2).—The platforms of the abutments were laid 34 ft. 6 in. below Trinity House water mark in the front, and 34 ft. 6 in. at the back; the two side piers 40 feet, and the middle piers 43 feet; over the whole surface, piles of elm, fir, or beech, 12 inches diameter and 20 feet long, were driven into the clay 18 feet below the platform, in rows, 4 feet asunder. All the piles were cut off to a level, and a space of 9 inches deep below the pile-head excavated and filled in with Kentish ragstone, well beat down, and racked in with five parts of sharp gravel and one part of lime; after which, sills, 12 inches square, were spiked on the pile-heads transversely; the intervening spaces were filled in with brickwork, excepting at the extremities, which were of stone. Above these sills there was laid longitudinally another row of sills, spiked down to the first row of sills with 18-inch jagged spikes, and the spaces between filled-in level with Bramley-fall stone. On these sills and stones was laid a platform of 6-inch beech, elm, or fir planks, bedded in mortar, and spiked down with 12-inch jagged spikes, and upon this timber platform the masonry was built. Round the abutment, sheet piles 6 inches thick and 18 feet long, and round the piers, 12 inches thick and 20 feet long, were driven in; the whole planed, ploughed, and tongued at the edges.

The masonry of the piers and abutments is formed on the exterior faces with granite ashlar, 2 ft. 3 in. to 3 feet thick, with headers 5½ feet long, and the interior filled in with Bramley-fall, Painshaw, or Derbyshire stone.

The five arches are semi-ellipses, the centre arch 152 feet span and 29 ft. 6 in. rise; the arch stones are of granite, 4 ft. 9 in. deep at the crown, and increasing to 10 feet at the springing. The two arches next the centre are 140 feet span and 27 ft. 6 in. rise; the arch stone 4 ft. 7 in. deep at the crown, and increasing to 2 feet at the springing. The two side arches are 130 feet span and 24 ft. 6 in. rise; the arch stones at the crown are 4 ft. 6 in. deep, increasing to 8 ft. 6 in. at the springing. All the stones are 18 inches thick at the intrados, and increase in thickness to the extrados, and each arch has four connecting bars of wrought iron.

The centres consisted of eight ribs of Baltic fir, excepting the springing-pieces, which were elm and the wedges oak; the covering of the centre was of timber 7 inches thick. The spandrils over the piers are filled up solid to the underside of the inverted arches, the depth of which is 6 feet in the middle of the two centre piers, and 5 feet for the two side piers.

Roadway.—The interior spandril walls to carry the roadway are of brick, three bricks thick, and on the top are stone corbels 18 inches deep, projecting 12 inches, over which are laid 9-inch Yorkshire landings, and then the whole surface of the bridge is covered with puddled clay 15 inches thick; over this, broken stone 12 inches thick, is laid; and then granite paving, for the footpaths and road.

Next mouth we shall resume our review of this valuable work; and in closing our present notice, we most strongly advise our professional readers to procure the work itself.

A Treatise on the Principles relating to the Specification of a Patent for Invention. By WILLIAM SPENCE. London: royal 8vo. V. and R. Stevens and G. S. Norton.

The abstract conception of a patent is perhaps one of the simplest of legal ideas. The jealousy with which property is guarded in all civilised states, and especially in this country, takes cognizance not merely of each individual's right of possession to his goods, chattels, and estate, but even of his claims of peculiar advantage derived from his ingenuity and contrivance, especially when his exertions tend to promote the general interests of the community. The poet who exalts the moral and intellectual condition of his countrymen, and the mechanist who enlarges their amount of physical happiness, have equally a reward secured to them by the law of the land; the publisher who pirates a copyright, or the manufacturer who infringes on a patent, are amenable to the same system of legal retribution that guarantees to every man that which is his own.

Simple and intelligible, however, as is this theory of patent right, its application to individual instances is beset with innumerable difficulties. The question immediately arises, what is the nature of those claims that demand the protection of a patent? Is it sufficient that the claimant should merely have discovered some new and useful principle, or must he, by an actual invented mode of application, have shown how that principle is to be rendered available? To take an example—would the first person who discovered the mechanical power of steam have been entitled to a patent unless he had likewise invented a steam engine? To this the reply is easy. A patent is the remuneration which the State accords to an individual for having realised or *done* something useful—not for having merely projected it. For the man who discovers a principle without applying it, cannot be said to have benefited his species; so far as he himself is concerned, his discovery is useless—he lacks either industry or talent to turn his knowledge to account; all he has done has been to enlarge the means of usefulness of other men, and to them, not to him, is the credit due of all that may result from the opportunities he has afforded them. The laws observed by Kepler, in his hands, might for ever have remained barren isolated facts, had not Newton applied them, and thus given value to what previously were worthless details.

It is clear then that patents are only due for inventions, whether they be modes of carrying out new and useful principles, or improvements on the methods of carrying out old and recognised principles. The next question that presents itself has reference to the absolute originality of the invention. Suppose an invention to have been made and not distinctly announced, nor so widely promulgated as to have been generally known, and suppose that a discerning individual, having by some means become acquainted with this invention, had discovered its merit, has he a right to a patent? Or suppose that another individual, without having been aware of its previous existence, had, so to speak, re-invented that invention, can he claim a patent? The answer to these questions involves all that is complex in the law of patents; the degree of promulgation necessary to invalidate the claims for the re-invention being so difficult to determine, that only persons accustomed to the niceties of law, and versed in the precedents of the courts, can in any particular instance venture to give an opinion. As a guide for patentees through the tangled mazes of the law we know no better work than Mr. William Spence's Treatise on the Specifica-

tion of a Patent for Invention. Mr. Spence has divided his volume into two parts, which together occupy about 180 pages. The first division treats of the defects of claims by which a patent is invalidated; the second of the conditions necessary to establish the specification secure against all attacks. The first division is prefaced by an introduction, in which Mr. Spence gives the following definition of a patentable invention:—

"It must be remembered that every invention has its birth at a given period in the progress of manufactures: that it takes up certain defects and proposes a plan for their remedy. This is the meaning of a patentable invention. In defining the true scope therefore of a particular subject matter of a patent, due attention must be paid to this its essential characteristic, viz.: that it leads us a step on the road to perfection in the branch of manufactures to which it belongs. Hence the necessity for clearly determining in the specification the exact position which the invention occupies in the march of improvement."

This definition appears to us too limited, inasmuch as it excludes all inventions founded on an entirely new principle; a patentable invention must be either something tangible, or some specified method of manufacture, the object of which is to produce something useful to society.

"Public user," is generally the claim advanced against patent right: on this subject Mr. Spence is particularly clear and copious. In a country like Great Britain, where the minds of men are constantly on the stretch to perfect the various departments of manufacturing art, inventions the same nearly in substance will often occur simultaneously or in succession to various persons. The question how far an invention for which a patent is sought has been previously employed is consequently often extremely difficult to be settled; experiments instituted for the purpose of obtaining a result which another, and perhaps, more lucky individual has at once arrived at, are frequently so like "public user," that the jury is deceived by their resemblance. Mr. Spence has extracted from the Reports one or two instances of the kind, and his comments upon them are worthy the attention of all patentees. Previous publication in a printed work of general circulation is another disqualifying fact—and the second treated of in Mr. Spence's work. Lastly, previous specification, on which subject we extract the following observations.

"But in applying this principle to practical cases, it is easy to see that the question mainly turns upon the legal sufficiency of the said specification: so that although evidence of public knowledge and public user is not required (as we have seen) in principle, yet in practice it is found essential from its bearing upon the question of sufficiency; for if the description of an invention contained in an inrolled specification be unintelligible or impracticable, there is no disclosure of a perfected invention. Now public ignorance and non-user are some evidence of this; inasmuch as they give rise to the supposition that the specified plan did not answer its purpose, and for that reason did not come into use, nor become publicly known. Hence it usually occurs that when a patent is alleged to have been anticipated by a former specification, the patentee rests his case upon his evidence of public ignorance and non-user, unless he is quite satisfied that there is no material correspondence between the two inventions, the latter consideration in such case affording ample grounds of defence against such attack. It is a source of increasing difficulty to the patentee that specifications are constantly being inrolled which may not attract public attention; there are also many in years past which are not known to the public in any practical sense, and are probably by no means easy of reference, owing to the vagueness and unsuitableness of their patents' titles: and yet these specifications when discovered are to be assumed as publishing to the world whatever they contain. According the legislature, sensible of the discrepancy between the principle of law that the inrolled specification renders public whatever it contains, and the actual fact, sensible also of the occasional hardship to which such discrepancy exposes the patentee, has devised measures for his relief, with the view, it would appear, of maintaining the said principle in its general applicability, but preventing it from pressing with undue weight in individual cases. The measures for relief specially alluded to are those contained in the act 5 and 6 Will. IV. c. 83."

In the next division, we find good faith insisted on, as the first and most necessary qualities of the specification. As, by the nature of a patent, the public are restricted from benefitting themselves by an invention, without duly recompensing the inventor, it is but just that the exact extent of the invention should be clearly known, lest the inventor be rewarded for more than is his due. There is another reason, too, why the specification should be clear and accurate—and that is, that the public may not be deceived as to the value of the thing protected, and thus be deluded into combining with the patentee to carry out an useless project. The next point to be observed is the order of the specification;—on this subject, as a remarkable instance of the perspicuity of our author, we shall quote, from p. 78, the following passage:—

"But we come now to that part of the specification which in a sense may be said to be the most important of all: the part referred to is the claim. It is here that the essence, principle or spirit of the invention is stated in the most distinct terms. The whole of the foregoing matter is here summed up and resolved into its one idea. All the previous description of circumstance comes now to be seen only as affording a clue to the right interpretation of this final definition of the essential character of the invention. The claim rightly understood is in fact the specification: but then in order that it may be rightly understood reference must be had to the antecedent matter: and it may indeed be said that the intelligibility of the whole specification greatly depends upon the particular interpretation of the claim which is suggested by such reference. It would be comparatively easy to discover what construction to put upon the claim provided all the former portions of the specification plainly referred to the main idea contemplated by the invention, but such construction becomes a difficult matter when inconsistencies are found to exist on a comparison of some statements with others. So far as difficulties of this kind can be overcome, they are sometimes obviated by stating the claim first in a negative form It is well to calculate upon every objection being raised to the specification that human ingenuity can devise: and accordingly it may be foreseen that the true, distinct nature of the invention is left open to misconstruction by a mere statement of what it is, since it may appear to be not only that, but something more also, (probably of a prejudicial character) unless guarded from such construction by a suitable negation. This course is particularly advisable when the patent is for a new combination of materials or processes, which in their separate form are old or not open to be claimed. Crane's patent is a case in point. It is described as consisting in 'the application of anthracite or stone-coal, combined with a hot-air blast in the smelting or manufacture of iron from iron-stone, mine or ore.' Now the patentee in this case, feeling that the ground to be occupied by his invention is narrow, proceeds in his specification very carefully to lay such a foundation as will lead to a right apprehension of his real subject-matter. He shows, that is, the importance in a commercial point of view of using the stone-coal in the manufacture of iron: and thence infers that the abandonment of the article after use (which he cites as a known fact) was owing to some imperfection in the means employed to adapt it to the purpose. He accordingly gives instructions as to a practical mode of applying it to this use, the essential feature in which is the adaptation thereto, and combination therewith, of the hot-air blast. And after describing the mode by which he had actually accomplished his purpose, he says:—'I would have it understood that I do not claim the using of a hot air blast separately in the smelting and manufacture of iron, as of my invention, when uncombined with the application of anthracite, or stone-coal and culm: nor do I claim the application of anthracite or stone-coal in the manufacture or smelting of iron, when uncombined with the using of hot-air blast. But what I do claim as my invention is the application of anthracite or stone-coal and culm, combined with the using of hot-air blast in the smelting and manufacture of iron from iron-stone, mine or ore, as above described.'

"The claim being in this form anticipates any objection that might be raised on the ground of interference with the hot-air blast patent of Neilson, except that Crane must take a license from him to use that part of the combination. It also avoids the objection of including what was known to be old in the manufacture of iron, so far as a series of (it would appear unsuccessful) efforts to make stone-coal available for the purpose coufd render it so. But it likewise sets at rest all uncertainty as to the real subject-matter of the patent by the positive form in which the claim is stated. So that the whole effect of the claim may be stated as follows:—'Although the patent is not for the use of hot-air by itself (that is Neilson's) nor for the application of anthracite or stone-coal without the use of hot-air blast (that has been tried and has failed), yet it is for the application of anthracite or stone-coal combined with the use of hot-air blast for the manufacture of iron.' And the only question that arises on the claim so stated is whether the subject-matter of a patent can stand upon such narrow ground. To this question the Court of Common Pleas answered in the affirmative—such opinion, in this case, resting upon the fact that the balance of evidence at the trial showed a substantive effect to have resulted from the combination, viz., an improved quality of iron at a diminished cost of production. It would seem that before the date of this patent the application of anthracite or stone-coal to the manufacture of iron was felt to a desideratum, but one which was not attained: the patentee, however, succeeded in producing better iron at a cheaper rate by the use of this article. To what cause then is his success attributable? The essential difference between his mode of operation and that practised by his predecessors was, that whereas they used stone-coal uncombined with a hot-air blast, he used it in combination therewith, and this being the only essential distinction between the two modes, to such is ascribed the difference of result."

The next two chapters, on the language and description of the specification, have reference to subjects of scarcely less importance than that on the order of the specification. We shall conclude our notice of the work by quoting from the final and recapitulatory chapter, the following admirable piece of advice, which all patentees would do well to consider:—

"The argument of the section of good faith is as follows: the general form and constitution of society, with its laws and orders, have come down to us through past ages with the authority of divine sanction; it is therefore the duty (as well as interest) of all who enjoy the protection of the law to uphold its integrity by honest compliance with its enactments in the

spirit as well as the letter—departure from which principle for private ends is wrong, and, because wrong, inexpedient in the long run.

"On this ground it is contended that those who purposely exaggerate or diminish, or otherwise distort the real facts which are proper to be introduced into the specification defeat their own ends and greatly injure themselves by blunting their sense of rectitude."

Treatise on Mechanics. By J. F. HEATHER, B.A. London: John Weale, 1847; royal 8vo. No. I. pp. 48.

To detect and expose error—no less than to supply correct information on all subjects connected with mechanical science—is the constant endeavour of the conductors of this Journal; and in no instance are we more forcibly reminded of the responsibility of our position, than when called upon to analyse the merits of educational works professedly adapted to further the ends we have in view. Mr. Heather's treatise is peculiarly of this character;—his claims on public attention rest mainly on a profession of elementary preciseness of style, as will be seen by the following quotation from his preface—which will likewise serve to indicate the general nature and plan of the publication:—

"In putting forth a work in parts, it is not usual to make any prefatory remarks, until the whole be completed; but as I shall introduce into the treatment of the subject, in its earliest stage, some new enunciations of important principles, and shall endeavour to show that considerable improvements can be made upon the manner in which this subject has been handled, by even its greatest masters, I have thought it more courteous to my readers, thus early to call their attention to the influence which these principles will exercise throughout the subject.

"My endeavour has been, in the first place, to attempt, with what success my readers must judge, to give clear and distinct definitions of the terms thereafter to be employed; and, in the next, to confine their use, on all occasions, strictly to the sense in which they have been originally defined."

In reply to all this, we are sorry to be compelled to state that the success of Mr. Heather has been in an inverse proportion to his pretensions, that his definitions are not clear and distinct, and that he has lamentably failed to prove—so far, at least, as he himself is concerned—that "considerable improvements can be made upon the manner in which this subject has been handled by even its greatest masters." We do not deny that Mr. Heather may be capable of clearly apprehending physical principles; but we do most positively assert, that he is utterly incapable of putting forth his conceptions either correctly or in a manner intelligible to those among his readers who may have taken up the subject of mechanics for the first time. His phraseology is inaccurate in the extreme;—terms constantly occur to which no definite meaning has previously been assigned;—his definitions are either old and well-known forms clothed in a new and looser garb,—or when original, generally incorrect.

Lest, however, we be accused of undue severity, we proceed to give extracts from the number before us,—pointing out the various inaccuracies and fallacies as they occur.

The first four paragraphs of the introduction being purely metaphysical, are, perhaps, not strictly within the province of a physical critique. We must, however, object to the assumption of the immutability of the law of nature, as derived from the immutability of their Divine Author. The same face that was smiling and beautiful at fifteen is wrinkled at fifty;—the same leaf that was green in June is brown in November;—the universe is in a continual state of change. Why, then, should the laws that govern this varying world be themselves unvarying? Why might not the purposes of Creation demand that they too should be subject to time, and *that* by an immutable decree of the Creator?

"While a certain determinate point with respect to a body, always preserves the same distances from the objects which surround it, the body is said to be at rest; and, when these distances undergo successive variations, it is said to be in motion."

This definition is neither new nor complete: it is incomplete because it is purely geometrical, and excludes all idea of the mechanical consequences of motion. Suppose the earth the only body in space—neither sun nor planets existing, to which to refer its motion;—then, according to the above definition, any point on its surface may be said to be at rest. But the variation of gravity at that point (supposed neither of the poles), arising from the centrifugal force, demonstrates that there must be a motion of rotation of the earth about an axis, and, consequently, that the point in question is absolutely moving, though, relatively to the other parts of the earth, at rest.

"Bodies, however different in volume, upon which the same force produces the same effects, are said to contain the same quantity of matter. The quantity of matter in a body is called its mass. Also, the greater the mass of a body, the greater the number of particles it is said to contain."

This definition is sheer nonsense. What are we to understand by the word effects? Are statical or dynamical effects here alluded to? If statical, behold the consequences of this certainly new definition. Suppose one pound of coals supported by a scuttle, and another by the surface of the earth;—then the weight of the coals "produces the same effects"—that is, the same pressures—on the scuttle and the earth,—*ergo*, the mass of the scuttle is equal to the mass of the earth. What Mr. Heather probably means is this:—Any two bodies are said to have equal masses, when equal velocities are generated in them in the same time, by equal, single, and invariable impressed forces, where by equal impressed forces we mean forces that would cause the bodies when at rest to exert equal pressures against fixed plane surfaces perpendicular to the direction of the forces.

From this definition of the word mass—combined with the fact, that the dynamical measure of gravity is the same for all bodies—we infer that the masses of bodies vary as their weights. As this definition cannot be understood by the tyro until he be conversant with the various measures of force, and the third law of motion, it ought to be deferred until those are explained. In the next number of the Journal, we hope to lay before our readers a short account of the measures of force,—the laws of motion,—and the meaning of the word mass, or quantity of matter. At present, we shall content ourselves with stating where we believe Mr. Heather to be incorrect, without any attempt at emendation—from which, indeed, the limits of a cursory review preclude us.

"12. Any two forces which are in equilibrium, when applied to the same material particle of any body, in the same right line, in opposite directions, are called equal forces.

13. A force which produces the same effect as two equal forces, applied at the same point in the same direction, is said to be twice one of these forces: a force which produces the same effect as three, is said to be three times one of them; and so on.

14. We are thus enabled to measure all kinds of forces, by units selected from the effects produced by forces of any one kind; and it is found most convenient to select these units from the effects produced by the attraction of the earth upon bodies near its surface. We find, in fact, that all bodies near the surface of the earth have a tendency to fall towards its centre; and when they do not so fall, we are enabled, in all cases, to trace out a sufficient cause which counteracts, and thus holds in suspension, the effect of this tendency; but the moment we remove the counteracting cause, the body begins to fall, and continues to do so, until it meet with some new obstruction.

15. When this effect is entirely uncounteracted, the same velocity is always generated in the same time in all bodies, whatever be their figures, volumes, and masses. This force, then, is called gravity, and is measured by the velocity generated in a second of time; and this measure is taken for the unit of measure of all other forces which are not in equilibrium, and when our object, consequently, is to find the relations between the forces and the motions produced.

16. When, however, we apply a force to a body in the opposite direction to gravity, so as to be exactly in equilibrium with it, and thus keep the body at rest, in which case it is said to support the body, we find that the force so applied must be in exact proportion to the mass of the body. The effect, then, of gravity in counteracting the effects of the other forces applied to a body, when it is kept at rest, is called the weight of that body; and, in the investigation of the relations subsisting between the magnitudes and circumstances of action of forces in equilibrium, the forces are measured by the weights of the bodies which they will support."

This is a jumble of inextricable confusion;—the explanation of measures of force—a subject of the first importance—is disposed of in about forty lines. One kind of force is described as producing effects two or three times as much as another; while the nature of the effects, and their susceptibility of measurement, are left entirely to conjecture. There are many causes followed by effects, which are not capable of being measured. Alcoholic liquors produce effects which are not capable of being measured. We cannot say that A is three times as drunk as B.

"Gravity, in fact, must be considered as acting upon every particle of which a body is composed, and generating in each of these particles, in the same time, precisely the same velocity; and thus these particles neither accelerate nor retard the motion of one another."

—Another instance of the inaccuracy of our author. This assertion, applied to rotating bodies, is absolutely untrue.

We have now arrived at the end of the introductory chapter;—the remainder of the number contains nothing very original or very incorrect. There is a fierce attack, near the conclusion, on Poisson,—founded on a misapprehension of his meaning; and an improvement

on the second part of Duchayla's proof of the parallelogram of forces—which consists in omitting it. On the whole, we think we have fully justified our opinion of Mr. Heather's merits as an author. We think it possible, as we have observed before, that it is to Mr. Heather's inability in writing—not thinking—that his deficiencies are due;—to whatever cause, however, they be assigned, we shall conclude by solemnly declaring, in old-lady-phraseology, that—A Treatise on Mechanics, by J. F. Heather, B.A., is a very improper work to put into the hands of young persons.

The Great Britain, Atlantic Steam-ship. Twenty-five folios of Engravings. London: John Weale, 1847.

Mr. Weale has at length produced this long-promised work, but not in the state he at first intimated: his reasons for not doing so he gives in his preliminary advertisement. "The *author*," he says, "had undertaken to provide accurate drawings, with a descriptive text, which he has totally disregarded, although repeatedly urged, during a period of two years." For our own part, we are at a loss to know who has the right to be called the author, or who the engineer of this vessel. Perhaps Mr. Weale can hereafter explain,—or we may be induced to say a word hereafter.

The plates are got up in Mr. Weale's usual good style, and possess sufficient interest to make it a work desirable for the engineer. We have views of the engines, the boilers, the screw, and some portions of the iron-work of the vessel, showing the joinings of the iron ribs and plates.

CHAPEL OF JESUS COLLEGE, CAMBRIDGE.

The following account of the recent restorations in this beautiful edifice is given by a correspondent of the *Athenæum*, with the subscription "D. S." The fellows of the College have done wisely in entrusting the restorations—not to a mere mason—but a very competent architect (Mr. Salvin), and it is to be hoped that no alteration will be made in the arrangements:—

"It is now more than a twelvemonth since I transmitted to you an account of the discoveries which have been made, during the last year or two, in the Chapel of Jesus College, Cambridge; in the progress of which so much of the beautiful architecture of the ancient Church of the Nuns of St. Rhadegund, which had been concealed for the last 350 years, has been once more exposed to the admiring eyes of the lovers of ancient Art. Since that time, further research has brought more of the original features of the church to light; so that, at the present time, sufficient data have been obtained from which to determine the plan, and in great measure the architectural character, of the entire building as it stood before Bishop Alcock (thereby setting an example followed, a few years later, by Wolsey at St. Frideswides, Oxford) pared off the excrescences to adapt it to the more moderate requirements of a College chapel. This interesting work has been done, with his usual ability, by Professor Willis. It is said of Cuvier that, 'give him a single bone, and he would reconstruct the skeleton;' and those who have heard or read the Professor's Lectures on the Cathedrals of Canterbury and Winchester will at once have discerned the same talent in him. Give him a few feet of original walling here—a broken shaft there—the fragment of a base or a bit of a string-course in some out of the way corner, where no eye less keen-sighted than his would have discovered it,—and in due time he will show you what the whole building must have been. The results of his investigations in the present instance have been laid before the Cambridge Antiquarian Society,—and will appear as one of the numbers of their Transactions. Meanwhile, I may state that this, which till within the last two years seemed to be a plain cross church without aisles or chapels, now proves to have been originally a spacious and magnificent edifice—an example of the purest early English style. The nave, which is now short and perfectly plain, is shown to have had aisles, the piers and arches of which were built up into the present walls, and are now partially uncovered; and to have extended much further westward, into the Master's lodge—one of the piers being actually discovered *in situ* in Dr. French's oven. The transepts had aisles or chapels opening eastward; and the gable wall of the northern transept was lighted by a large round-headed triplet, which has been blocked by the College buildings abutting against it. On either side of the choir, were two arches opening into aisles or chapels; and the east wall was pierced by a triplet of lancet windows with black pannels between. The shattered remains of the original architecture are of such exquisite beauty, that even had Bishop Alcock's alterations been in the purest taste of his day we could scarcely have forgiven him the act of mutilation; but when we glance at the mesgre, low-browed windows, flattened ceilings, and other inelegancies perpetrated by him, it must be admitted that the good prelate was almost as much devoid of taste as any whitewashing churchwarden of the last fifty years. Of course, it is vain to hope to restore all the fallen glories of the church of St. Rhadegund. We cannot expect that the Master should give up his house and his oven to reconstruct the nave—useless as it would be for the purposes of the chapel of a by no means large college; nor, however gladly we should watch the restoration of so interesting an architectural monument, can we desire it. Still, it is cheering to see that what is practicable is being done, and that more is in contemplation. The eastern aisle of the northern transept and the northern aisle of the choir have been rebuilt under Mr. Salvin's directions; and the arches opening into them—which were discovered built up in the wall with scarcely a moulding injured or a point of the dog's-tooth broken—carefully restored. More beautiful early English arches than those in the choir it would be hard to discover; and the pier supporting them is a most graceful combination of four cylinders, contrasting very remarkably with the sturdy little dwarf column brought to light in the transept. When the no less beautiful arches on the south shall be also opened (a work which I trust is only deferred for a short time), the present poor flat ceiling be replaced by the original high-pitched roof, the wiry Tudor tracing of the east window make room for the triple lancet—both of which latter alterations will, it is understood, take place in the course of the ensuing summer—and the paltry fittings of painted deal shall have given way to the rich oak stalls which are already being carved after the original model (one having been, fortunately, preserved in the Lodge when the chapel was 'repaired and beautified' in the dreary last century),—I know not where we shall be able to find a more exquisite example of the pure and graceful architecture of the thirteenth century, or a college chapel (with the exception of King's as beyond all comparison) more beautiful and interesting. By the munificence of the Master, Dr. French, the four lancets to the north will be filled with stained glass by Wailes,—and the eastern lancets will be similarly decorated. The glass in the present east window will be removed to the large window in the south transept, which is well calculated to receive it. It is also gratifying to be able to state that the spirit of improvement has extended from the fabric to the services of the chapel: an individual member of the College having offered to present an organ, and to train and endow a choir, which will be accommodated in the aisle recently constructed. The same generous benefactor has presented the college with a statue of Bishop Alcock,—which now fills a niche in the tower over the great gateway. The improvement, both in effect and in meaning, is immense. I trust that the college will carry on the good work of restoration by banishing the sash windows and replacing the mullions, at least in the tower windows, if not in the whole front. It is too much to hope for the restoration of the original proportions of the façade by the removal of the upper story;—which, as may be seen from Loggan's View, is a later addition, sadly interfering with the dignity of the tower gateway. Much, however, has been effected in a most praiseworthy manner; and it is to be hoped that those to whom their college is an object of affectionate pride will come forward to aid in the completion of a work so interesting as the restoration to its original dignity and beauty of the chapel in which Cranmer and Pearson once worshipped."

CANTERBURY CATHEDRAL.

At the *Archæological Institute, March* 5, Prof. WILLIS delivered a lecture "*On the Conventual Buildings attached to the Cathedral at Canterbury*," when that beautiful edifice was the church of the Benedictine monastery there. He had given, he said, to the Cathedral, on another occasion, an entirely separate examination; and it was not his intention to allude to it at all, but he should confine the observations which he had to offer to the remains of the conventual buildings. These were interesting, though, unfortunately, concealed, for the most part, in the gardens and private apartments of the canons; but every opportunity had been afforded him for making a careful survey of what remained. The result of his examination was now before them; and, though interesting in itself, he should not have engaged the attention of the meeting on this occasion, but for the curious elucidation which the existing remains receive from an ancient drawing in a Psalter preserved in Trinity College, Cambridge. This drawing was engraved, but not very well engraved, in the second volume of the "Vetusta Monumenta." It has hitherto gone without a name (for none is given); but the result of his researches would show that it was meant for the Benedictine monastery at Canterbury, and made some time between the death of Anselm and the fire described by Gervase the Monk, in 1174. Of this drawing he had made an enlarged and accurate copy; and his object was, to show the extreme fidelity of the drawing and the interesting illustration which it receives from the scattered ruins that still remain. It would be observed, that the drawing in the Psalter was a kind of bird's-eye view; and that the monk by whom it was made was no great master of the rules of perspective—for some of the buildings are drawn upon their heads, and others upon their sides; but still, it was easy to understand it. Here, in the monk's drawing, is the church of the monastery;—here the outer walls and principal entrances;—here the chapter-house, cloisters, refectory, dormitory, necessarium, kitchen, brew-house, bake-house, granary and infirmary;—here the prior's house, the apartments of the guests, the hall or refectory for guests, the cemetery and the castellum aquæ,—by far the most curious part of the whole drawing, because it informs us of the ingenious and admirable contrivances of the monks for the thorough supply of the whole monastery with water. The Norman gate-

way, the principal entrance to the monastery,—represented in the drawing of the monk—still remains: and he did not know a more beautiful example, though somewhat altered in the upper story and disfigured by minor additions. The gate of the cemetery no longer exists. The cloisters in the drawing are Norman, though now Perpendicular, and with some traces of their Norman origin. The dormitory running from the cloisters was 145 feet by 80; and the Norman piers of the substructions, with some of the Norman windows, still remain. In a private garden belonging to one of the canons is a Norman cloister, very little known, but a beautifully simple piece of architecture, more like an Italian church or one of Wren's or Inigo Jones's constructions,—and a curious example of the slight separation between the Romanesque and the style from which it was immediately derived. The necessarium (now the site of the house of one of the minor canons) was 130 feet long, with fifty stone seats on each side, and a drain under each of the aisles. The place was most ingeniously drained and ventilated; for the monks were in advance of the rest of the world not only in learning, but in the conveniences and comforts of domestic life. Of this necessarium certain Norman traces remain. Of the refectory, only two sides are at present standing; but traces exist of a fine octagon kitchen, of a brewhouse, bakehouse, granary and infirmary. The infirmary was a building complete in itself; having a chapel, hall, refectory and necessarium. This was generally the case; and he would remark, in passing, that the whole establishment of the sick at Ely has been called the early church of the Cathedral,—when, in truth, it was nothing more than the infirmary of the sick.

Of the prior's house every portion has been swept away except a cloister under the prior's chapel. This house would appear to have been so ingeniously situated and contrived that the prior could see from his own house the principal altars of the church. Of the rooms set apart for the guests a Norman gateway still remains; and the hall, or the refectory for the guests, has been floored and fitted up as a residence for one of the minor canons of the Cathedral.—He would return to the subject of the distribution of the water; and would first direct attention to the number of straggling lines running about the drawing of the monk—some green, some red, and some yellow. These were water-courses—for the drawing would appear to have been made to show not the elevations of the monastery, but the machinery used for the distribution of the water. The canons of the Cathedral are still supplied by wooden pipes from the reservoir in use when the drawing was made. The reservoir was about a mile out of the town; and the water-course led to a circular building at the end of the beautiful Norman cloister to which he had already referred. This circular building has hitherto been called the baptistery—but it really is nothing more than the castellum aquæ of the drawing; and on a minute examination he discovered, on clearing the rubble out, the hollow pillar in the centre (represented in the drawing) by which the castellum aquæ was supplied with water.

REVULSION IN THE MANUFACTURE AND TRADE OF COPPER.

The copper mines of Cornwall and Wales have, hitherto, yielded 16,000 tons of copper annually; for which, however, 170,000 tons of ore were required, as they do not yield more than an average of 9½ lb. per cwt. These mines will no longer be able to compete with those of other countries, discovered or even worked at the present moment. We allude chiefly to the South Australian mines; the more so, as their riches seem inexhaustible, and lay so close to the surface, that their working will require little skill and expense. In 1845, the first year these ores were brought to England, their value scarcely amounted to £16,000, while last year it had extended to £100,000. It would, perhaps, have far exceeded this sum, had not the simultaneous discovery of gold diverted attention and capital therefrom. It is to be expected that the great influx of emigration to that quarter in general, as well as the aid of German (Freyberg) miners, will soon enable the colonists to have their own furnaces, and supply the markets of India and China, which hitherto have been partly supplied with copper from England.

The mines of North America are next to be alluded to, which were known even so far back as when the Jesuit Charlevoix visited these places, where (the north-west lakes) he says copper was made into candlesticks and other church implements for the use of the missions. In 1773, a British copper-mine company was formed, but the succeeding revolutionary wars and territorial disputes rendered it ineffective; but, of late, more than a hundred mining companies have been formed on Lakes Huron and Superior. The American press is full of the praises of the riches of these parts in silver and copper; large masses have arrived at Boston, where extensive smelting works are being established, which will make this place the Cornwall of New England. In other parts of the United States also, as in New Jersey and Missouri, vast layers of copper have been discovered, at which latter place, the mine of Buckeye yields already 15 tons of ore daily, containing 37 lb. per cwt. of copper.

The prospects of Canada are equally cheerful, and the strata of this part of Lakes Huron and Superior are very profitable, and companies have been formed both in Montreal and Quebec, whose surveyors were very active last season. The Quebec society have begun operations at Maimaase, and the first samples of ore yielded a gross average of 30 lb. per cwt. of copper. The society of Montreal have begun the construction of furnaces and pounding engines on a large scale. Their surveyors have found large lumps of copper, one of which weighed two tons, and seams of that metal 60 feet wide by 70 feet deep. The ore is conveyed through the lakes and canals to the St. Lawrence, and it is intended to cut a new canal at the Sault Ste. Marie, where the communication between the Huron and Superior takes place. As the mine district is a very barren one, profitable employment will thus accrue to the surrounding corn-growing lands.

J. L——Y.

THE CENTRAL SUN.

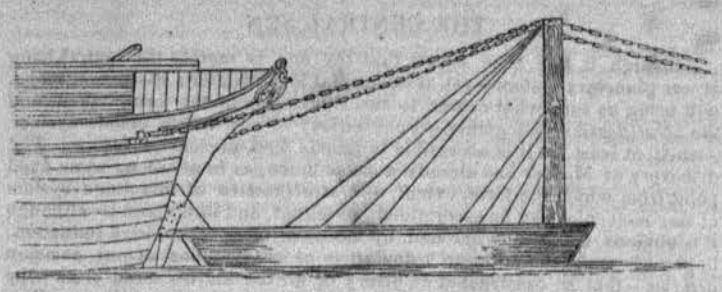
Although it has been *known* that the sun is merely the central body of *our* planetary system—yet, it seems that it is Mädler's discovery, which will bring us somewhat nearer to the elucidation of the form, extent, and the *stratification* (altogether—*organisation*) of our whole *cosmic* system,—such, at least, as it is accessible to human ken, present or future. The discovery of Mädler has already done so much, as to afford us some fixed point from which the form, extent, and *stratification* of this huge system of star-molecules can be ascertained, measured, and laid down;—although it is obvious, that *if* any one had, by means of mere speculative induction, begun to extend the hitherto calculation or construction of our common orreries—that is, constructed an orrery of all the known fixed stars—the central sun in the Pleiades would have been arrived at, *ipso facto*. But, Prof. Mädler's central sun is (by his own statement), *not* the real central sun, as he *excludes* from his system the *Magellanic clouds* and other numerous star-nebulæ. Then, therefore, only when these vast accumulations of milky ways will have been properly observed and studied, the true central star of the *cosmos* will be ascertainable. But, even now, the calculation and construction of a world's-orrery is becoming a great desideratum. The scale, certainly, as we have to deal with 34,000,000 of parallaxes of the sun—will be a difficult task; still, it is not so much the laying down of single stars (evanescing in such spaces), than the configuration and stratification of what Mädler calls "rings and layers" of stars, which will be the most important. It is impossible, in viewing these subjects, not to think of the *macro-cosmos* of the ancients, or still more of what Pliny conjectured on this huge world-system, in saying—"Mundum—seu quod alio nomine Deum nuncupari fast est." Lib. II. 1.

J. L——Y.

THE RECOVERY OF THE SPHYNX STEAM SLOOP.

The recovery of the Sphynx steam-sloop from the fate which was generally predicted for her, has reflected much credit on Captain Austin, C.B., Commander Caffin, Lieutenant Thompson, of the Victory; Mr. Bellamy, assistant master attendant of Portsmouth Dockyard; Mr. Biddlecomb, master; and Mr. Mallard, second master of the St. Vincent, and the officers and men of the royal navy, and Mr. Watts, assistant master shipwright, of Portsmouth Dockyard, to whom was entrusted the task of recovering this fine steamer from off the coast at the back of the Isle of Wight, where she stranded in February last, during a fog. It is impossible to commend too highly the exertions of all engaged in the arduous task, and the cheerful manner in which they endured all sorts of privations. Commander Caffin, of the Scourge steam sloop, was first sent to assist in getting off the Sphynx. He at once saw the necessity of mechanical help, and immediately applied to the Portsmouth dockyard, when Rear-Admiral Parker ordered Mr. Watts to go to her, taking 50 mechanics of different departments; and no time was lost in consulting on the best means to be adopted. It occurred to Commander Caffin that they should avail themselves of the paddle beams and framing to apply buoyant vessels of some kind underneath, and Mr. Watts thought a raft of casks or of tanks might answer the purpose. The difficulty, however, of lashing or uniting them together sufficiently securely to withstand the immense force of the rollers and breakers, so common off that part of the island, was seen, and Commander Caffin then suggested the London barge, decked over and applied as camels underneath the paddle-boxes. On this the framing was immediately planned, and Mr. Watts's designs were received at Portsmouth-yard, where it—together with the barges—was prepared. In the first attempt with these barges they failed, in consequence in part of one of them having received injury for want of sufficient security. Unfortunately it forged ahead, and the pump, which projected up through the deck, came in contact with one of the bearers of the framing, and ripped up a portion of it, which caused it to fill. But even if this accident had not happened, the change of weather would have defeated them. They profited by this experience, and Commander Caffin having left, Mr. Watts went to work to remedy and improve on the first attempt; and Captain Austin having arrived, determined on carrying out the plans agreed upon. The barges were found not to possess sufficient buoyant power, and consequently they were raised upon so as to bring them up to about 140 tons. Mr. Watts found that the nose of the vessel, instead of being lifted over the reef

rocks or banks, was rather forced into it by the downward action of the cables when hove upon; to obviate this he had a third barge or camel prepared, with a framework at the extreme end sufficiently high (as shown in the annexed engraving), that when the cables, hawsers, &c., were carried over it, this downward action, instead of depressing the vessel, should produce the contrary effect. To accomplish this he placed at the opposite end of the camel, firmly secured to its deck, two strong pieces of timber, kept sufficiently asunder for the stem of the vessel to pass between them, so that they forked the stem. Attached to the stem, immediately over this fork, was a strong cleat on each side. By the depressing of the end on which the frame was placed the end next the vessel was raised, and an upward pressure on the cleats resulted therefrom. Beyond this a great portion of the buoyant power of the camel came into operation. The undulations of the sea also contributing to increase its effect.



The Sphynx, cleared of everything except her engines, drew upwards of ten feet of water; and the reef over which she was ultimately carried had not more than six feet on it at the time. She had twice before been brought up to this point, and could not be got over it; but on the 3rd ult., by the joint effects of the camels under the paddle-boxes—the one against the stern, nicknamed the dromedary, and the two tiers of casks (alias bulls), under the bottom, and main strength in heaving, she effected the passage. The outer shoal or reef, on which there was only about six inches more water than on the inner, brought her up again. The purchases having been perhaps prematurely detached from the vessel, not expecting that they would be further required, they impeded the progress of the vessel over the intermediate flat, and would perhaps have prevented her reaching the outer reef in time to get over in that tide, so that the result would have been the same in either case; thus she was not got entirely over these reefs before ten o'clock on Thursday morning, the 4th ult.

The "recovered" Sphynx was then taken into the Angle Dock at Portsmouth, on Saturday afternoon, the 6th ult., when it was stated that the vessel was much strained, inasmuch as the bed-plate and condenser of the engines were both broken, the former in several places. The kelson bolts were also several of them started up by her thumping on the rocks. The engines and boilers have to be entirely removed to repair the injuries sustained by the keel and bottom planking. The lower part of the knee of the head was carried away on the 14th of February, by the chain cable, when the vessel went broadside on the shore.—The Sphynx was afterwards brought round to Woolwich, where she is undergoing repair, and the engines are in the hands of Messrs. Penn, of Greenwich, who recently constructed the engines, which are of the oscillating principle.

THE NEW PLANET.

At a meeting of the *Astronomical Society*, February 12,—Capt. W. H. Smyth, R.N., President, in the chair,—The Report for the past year was presented by the Council, and read.—On the motion that it be adopted, an amendment proposed by Mr. Babbage, and seconded by Dr. Fitton—That this meeting express their deep regret that the Council have not awarded the Society's medal to M. Leverrier, for his publication of the greatest astronomical discovery of modern times—was negatived. A second amendment proposed by Lieut. Raper, and seconded by Capt. Bethune,—That it is the opinion of the meeting that the unprecedented discovery of a new planet by theoretical researches, and the acknowledged title of M. Leverrier to the honour of that discovery, demand for him some special mark of the approbation of this Society; and it be recommended to the new Council to convene a Special General Meeting of the Society, on as early a day as may be convenient, for the purpose of suspending Articles 2, 3, and 4, of Section 16 of the Bye-laws; and that the printing of the Report be deferred till the subject shall have been brought under the consideration of such Special General Meeting—was negatived. A third amendment proposed by the Rev. R. Sheepshanks and seconded by Mr. Drach—That a Special General Meeting be called to consider the propriety of granting a medal to M. Leverrier, for his researches respecting the planet exterior to Uranus, and a medal to Mr. Adams for his researches on the same subject—was also negatived. A fourth amendment proposed by the Astronomer Royal and seconded by Dr. Lee—That a Special General Meeting be called after the ordinary Meeting of March 12, to consider the following resolutions:—That so much of the Bye-law as relates to the number of medals which may be adjudged in any one year, the time of giving notice of the proposal for a medal, the time of adjudging the medal, and the time of presenting the medal, be suspended *pro hâc vice*; That the Council be authorised to award two (or more) medals, if they shall deem it expedient to do so; That the award of the Council be communicated to the Society, and that the medal or medals be presented at the ordinary meeting of April 9—was carried.

BUDDHIST ARCHITECTURE.

At the *Royal Asiatic Society*, Colonel Sykes read an extract from a letter received from Captain Kittoe, who has been making some recent antiquarian researches about Gyah, anciently one of the seats of Buddhism, described by Dr. Buchanan Hamilton, in the second volume of the Society's *Transactions*. Capt. Kittoe states that he has found and copied a number of inscriptions, some of which he promises to send to Col. Sykes; and that he has heard of others, some miles inland, never yet seen by any European, which he intends examining. He was unsuccessful in his search after remains of Buddhist architecture, having met with but four or five fragments; but he found a great number of small sculptured stones, which he thought were miniature chaityas or shrines, a sketch of one of which he forwards in his letter; the base being a cube, the upper plane surmounted by a hemisphere, from the apex of which rose an obelisk. In each of the four vertical faces was a compartment, containing a figure of Buddha, the figures in different attitudes; and he states that such stones are found, not in Behar only, but in Cuttack also, where he has seen several. He remarks that they resemble closely the pagoda at Rangoon, where five hairs of Buddha are kept as relics. Many of these are of elaborate workmanship; and some have images of Buddha in various postures in the different compartments; generally sitting with the hands folded, but sometimes erect; and a few seated on a bench. One of them, which he has in his possession, is inscribed with the usual Buddhist formula, *yedharma hetu prabhava*, which is decisive of its appropriation. Col. Sykes observed that these chaityas in all probability are representations, or the identical shrines seen by the Chinese traveller, Fa-hian, at the beginning of the 5th century of our era; and afford a valuable attestation to his truth respecting the then existing belief in the four Buddhas, the *predecessors* of Sakhya.

Captain Kittoe believes the present temple at Gyah to be less than 600 years old, and to have been built for the joint worship of Siva and Buddha. He thinks he shall be able to trace the amalgamation of the sects by their sculpture; and he is preparing to make drawings of the most interesting of these relics. Captain Kittoe states that he has discovered another of Asoka's pillars, at Bukrowe, the site of an ancient city of the Buddhists, on the banks of the Lilajun. It was broken, many years ago, into three pieces, one of which was brought to Gyah by Mr. Bodham, and set up in the bazaar, where it goes by the name of Bodham's Folly, an apt illustration of the light in which the natives of India, and too many of our own countrymen, regard the preservation of such remains of past ages, from which alone the recovery of any portion of the ancient history of the country can be expected. The Raja there suggested to Captain Kittoe that he should make rollers for the roads of the fragments of the pillar! One piece of the pillar, the base, is almost entirely buried beneath the surface. Captain Kittoe is about to dig it out, with a view to its preservation.

Colonel Sykes remarked that this discovery affords another proof of Fahian's trustworthiness, as it has brought to light another of the pillars mentioned by him, but which had hitherto escaped notice.

LITHOGRAPHIC STONE IN ARABIA.

At the *Royal Asiatic Society*, the secretary read a paper which had been furnished by the Hon. East India Company, containing an account of the discovery of a quarry of good lithographic stone on the southern coast of Arabia, which will be available for our presses in Bombay, and other parts of India, which at present import a considerable quantity of that kind of limestone from the quarries of Germany. The discovery is due to assistant-surgeon H. J. Carter, who is employed in the survey of that coast. In the course of his duties, to the N.E. of Aden, Mr. Carter found that much of the land was of calcareous formation, of various series; the limestone was of a very fine grain, which induced him to gather some specimens, and forward them to Dr. Buist, of Bombay, for the purpose of trying their quality in lithography. The stratum composing this fine-grained stone lies three or four miles inland, and close to the summit of a descent, down which the blocks might be rolled, with very little trouble, close to the water's edge, where they might be immediately shipped. The inhabitants of the country, though somewhat fierce, are easily managed by proper treatment, and would readily protect persons employed to work the quarry; and Mr. Carter suggests that means should be taken to ascertain the quantity of produce the quarry is capable of yielding,—an investigation which his duties on the survey did not allow him leisure to pursue.

The report of Dr. Buist was very favourable to the quality of the stone. It was repeatedly tried, with some disadvantages, upon the native presses, and found to take the drawing with perfect facility, and to print with a purity not surpassed by the very best stones imported from Munich. Dr.

Buist gives some account of the native presses, of which there are above a dozen in Bombay alone; with details as to the expense of quarrying and freight, and the probable price and consumption in India; and is of opinion that the stone might even be advantageously carried to England. He concludes with recommending the Indian government to direct a few tons to be brought to Bombay for the purpose of making the experiment on a larger scale, by the first vessel in their service which may chance to be in the neighbourhood of the rock.

COPPER MINES IN ARABIA.

A paper from Mr. Carter was read at the *Asiatic Society*, "*On the Copper-mines in the island of Masseera, on the coast of Arabia*," which he had been induced to search for in consequence of receiving information that the Persians had formerly wrought copper-mines in the island. He had made several attempts to find the mines, but without success; the natives denied all knowledge of their existence; and he was about to relinquish the search, when, landing one morning in the month of February, 1846, on the westernmost part of the island, he accidentally fell in with some patches of blue carbonate of copper,—a specimen of which was laid upon the table. Mr. Carter, now confident of success, at once proceeded to search the neighbourhood. He soon fell in with some old smelting places; and immediately after found the vein itself, with the mineral *in situ*. After describing the nature of the mine, which appears to have been little worked, Mr. Carter states that he afterwards found copper in other places; and that the inhabitants, finding concealment no longer possible, discovered to him, of their own accord, other veins and smelting places, which they said had been built by the Feringhees. Mr. Carter states, that the inhabitants, though at first fiercely opposed to the landing of the surveying party, were soon conciliated; and that the utmost goodwill subsequently prevailed among them during the whole time the vessel remained in the neighbourhood. They are very steady and industrious; and their habits are in decided contrast with those of the Bedowins on the main land; and he is quite satisfied that any attempts to work the mines would meet with every assistance in the power of the natives to afford.

TYRE AND SIDON.

A paper by Capt. Newbold was read at the *Royal Asiatic Society*, "*On the mountainous country between the coasts of Tyre and Sidon and the river Jordan*," a part of Palestine hitherto almost a complete blank in our maps. Captain Newbold proceeded in 1845 from Tyre to Banias, and returned from Hasbeia and the castle of Shukif to Sidon. He thus traversed the country in two directions; and brought back with him a copious list of geographical names in the original orthography, most of which are wanting in Mr. Smith's valuable catalogue. The country is divided into the districts of Esh-Shukif and Beshareh; it comprehends an area of 468 square miles, being about 26 miles from north to south, and 18 from east to west. The shore district is the celebrated Phœnician Plain; it rarely exceeds two miles in width; and in many parts the mountains come down close to the sea in bold precipices. The maritime tracts are undulating, and vary in elevation from a few feet to 100 yards. The inland portion is about 200 feet high; reaching in some places to near 4500 feet, and separated by very narrow valleys, which are extremely deep and precipitous. Two rivers, the Litani (the ancient Leontes), and the Lohrani, pass through it to the sea; and a number of small rivulets, running to the Jordan, drain it towards the west. The principal rock is the marine limestone of Lebanon, penetrated by extensive dykes of basalt, accompanying lines of fracture, which appear to be connected with the fearful earthquakes of which the country has so frequently been the theatre. The crater of an extinct volcano, with its steep and rugged sides of lava, and evident traces of former action, were seen by Messrs. Robinson and Smith, and described in their work. Much of the country is cultivated; wheat-fields are numerous; and the vine flourishes in the volcanic soil: cotton also grows, but the staple productions are wheat, millet, beans, tobacco, and lentils. The population amounts to 15,090,—about thirty to the square mile; and is composed of Greeks, Druses, and Arabs. Captain Newbold examined the cavities in the coast which have been taken for the dye-pots of the Tyrians, and found them to be nothing more than natural rock basins, excavated by the action of the tide. He says they occur all along the coast of Syria, from Gaza to the Orontes. The old city of Tyre is buried under the sands; and forms an inexhaustible quarry whence materials are drawn to build and enlarge the cities in the vicinity. Captain Newbold saw a beautiful marble torso of Minerva, as large as life, recently found among the ruins, and now in the possession of a native of Tyre. He communicated the circumstance to our consul at Beyrut, with the hope of preserving it from further injury. Some interesting accounts of remarkable spots in the interior, which were visited by Captain Newbold, concluded the paper.

OF THE SUCCESSIVE PHASES OF GEOLOGICAL SCIENCE.

Abstract of lecture delivered at the *Royal Institution*, March 5th, by Prof. ANSTED.—The lecturer stated that he proposed to give something of a psychological view of geological history,—tracing the successive ideas that seem to have chiefly contributed towards the advancement of the science,—and pointing out how far these ideas involved truth, and how far errors of exaggeration, although they were useful as suggesting new views and observations. After reviewing the philosophy of the ancients and the cosmogony of the Middle Ages—which latter he described as without the true aspect of philosophic investigation—the lecturer referred to the discoveries of Werner as being the first which distinctly created geological science. He stated that these discoveries induced three important assumptions:—first, that the whole crust of the earth had been deposited mechanically from water; secondly, that the newer deposits were generally horizontal; thirdly, that there was an invariable order of superposition of similar mineral types. The idea thus involved was that of "the universality of formations," and a perception of order in the arrangement of the materials of which the earth's crust is made up; and the idea was described as useful and suggestive, although the conclusions were in many important respects unsound. While Werner was thus laying the foundation of geology by observations and speculations on mineral structure, William Smith, the father of English geology, had obtained an insight into an important fact concerning the distribution of fossil bodies; and at the same time Dr. Hutton, in his "Theory of the Earth," had recognised a succession of worlds and a history of the nature of the succession by the agency of causes not different from those still in action. The idea involved in the discoveries of Smith was, that "fossils are characteristic of formations;" while Hutton first appreciated the importance of existing causes. The next step in geological discovery was described as the result of Cuvier's investigations in palæontology, and the establishment of the law of the adaptation of structure to habit in all animals. This law, however, is combined with another, also of great importance—that there is in all nature a permanence of typical peculiarities. Modified and brought to bear on fossils in this way, the "law of universal adaptation" was described as the suggestive idea in this step of geological progress;—while the law afterwards made out concerning the *representation* of species in time as well as space was mentioned as affording important accessory aid in applying palæontology to the determination of geological problems.—After referring to the subject of geological classification, and describing it as the result of the working out of these various laws, the lecturer briefly stated the actual results of observation in descriptive geology, and the nature of the most remarkable speculations in physical geology;—but the latter were rather indicated in allusions to the desiderata in that department than dwelt upon or described directly. Among these desiderata he particularly referred to the condition of knowledge with regard to metamorphic rocks,—and their relations with rocks of distinctly igneous origin, on the one hand, and the fossiliferous stratified rocks on the other. He stated that much yet remains to be done in connecting the present with the immediately antecedent condition; but expressed grounds for belief that investigations actually in progress may lead to some satisfactory and fixed conclusions. The making comparative observations on a large scale was mentioned as an important means of advancing geological science: and in conclusion, Prof. Ansted spoke of the necessity of distinguishing in all cases the true objects of geology—and stated his firm conviction that geology would soon occupy a very important place as an inductive science, leading to great practical results.

RAISING AND SHAPING METAL BY STAMPING AND PRESSURE.

Abstract of lecture delivered at the *Royal Institution*, March 19, by Mr. CARPMAEL.—The lecturer's purpose was to show how objects of extreme perfection of workmanship and of great use in daily life are produced by simple manipulation. Having adverted to the old process of stamping sheet metal, and remarked that this process generally required that the article stamped should have a flange or rim, and that the process was inapplicable to any ornamental work which required undercutting in the sculptured part, Mr. Carpmael proceeded to describe the improvement lately introduced by *spinning* (i. e. burnishing to form), which is performed by fixing the object in a lathe and pressing its surface with a blunt tool; and explained how, by means of a divided mandril, undercut forms could be obtained. He then pointed out that this burnishing to form could be alternated with *casting*, and that the flange was rendered unnecessary in the casting process—the metal being driven through a conical mould much on the principle on which pipes, &c. are drawn: the difference being that in the process which he was describing, the object was forced through the gradually-contracting aperture by the blow of a heavy weight falling on its lower surface. Mr. Carpmael presented an example in a tea-pot, made of tinned iron plate by the joint process of casting and burnishing to form. This article, which is of the best fabric, is sold (wholesale) for 1s. 8d. Mr. Carpmael also exhibited the machines by which tin is shaped into boxes and bottles for holding colours, perfumes, &c., by squeezing a small ingot of this ductile metal by a powerful pressure.

HISTORY OF ENGINEERING.

By Sir J. Rennie, President of the Institution of Civil Engineers.

(*Continued from page* 81.)

Railways.

Whilst the turnpike road and coach system was rapidly advancing towards perfection, numerous active and inventive spirits, aspiring after better things, were busily employed in racking their brains to invent a mode of travelling, or locomotion, which should far exceed its predecessors; great difficulties however presented themselves—and amongst the agents which were thought of, none appeared so well adapted for the object as steam, the success of which, in the hands of Watt and others, had proved so triumphant, wherever it had been applied; but, in order to attain the wished for velocity, a different kind of road was required to that which had hitherto been used: and at length the railway system was introduced.

Railways, formed with wooden rails, or parallel pieces of wood, with carriages having wooden wheels to run upon them, had been in use at Newcastle as far back as 1681, for the purpose of conveying coal down from the mines to shipping-places on the banks of the Tyne; Labelye, in 1743, described improved carriages, used by Allen in stone quarries at Bath, having wheels with flanges of cast iron, adapted to run on wooden edge-rails; being an improvement upon those at Newcastle; afterwards, the wooden rails were plated with iron, which made the carriages run more easily with a greater load; cast iron rails. or plates, were brought into use for the first time by Reynolds of Colebrook Dale in 1767; and more completely by Curr at Sheffield, with wagons having cast iron wheels without flanges, the rails being in the form of tram plates; and in 1769 Edgeworth introduced three or four wagons drawn in a train, by one horse. These iron tramways, laid upon stone blocks, with the carriages above described, having smooth-tyred wheels without flanges. came into general use, for drawing coals, stone, and other minerals, from the mines and quarries underground, and at short distances from canals; but no lines of any great length were made for general traffic. The first line of any any extent, it is believed, was that at Loughborough, by Jessop, in 1789; also between Cardiff and Merthyr Tydvil, the act for which was obtained in 1794; this was followed by the Croydon and Surrey railway between Wandsworth and Merstham, in 1804: for the periods, all these were considerable works of the kind. About this time railways were used by the contractors during the execution of great works, at the London, the East, the West India Docks, and other places, where the transport of vast masses of materials was required; when the works were completed, the rails or plates, which were made with side flanges to keep the wheels in the places, were generally sold, and were occasionally used for constructing short lines to canals and shipping places. The only power applied to draw the wagons was that of horses. These railways were considered inferior to canals, and were seldom used, except when the traffic was chiefly descending, so that the empty wagons could return with facility.

Locomotive Engines.—The application of steam power to the propulsion of carriages might, it would seem, have naturally commenced with carriages on the common roads; but so many difficulties intervened, that the attempt was not made until after it had been effected on railways. Dr. Robison proposed it to Watt in 1769, and Darwin mentions it in 1796; but the application of Newcomen's or Watt's engines, for propelling carriages, could not be attempted with any probability of success, as they required copious and constant supplies of cold water for condensing the steam, which would have rendered the machine so cumbersome and unwieldly as to be unmanageable. Watt's practice was to condense the steam at a comparatively low temperature: for although he tried it in almost every state, from high to low pressure, he ultimately, under all circumstances, preferred employing steam at about 3 lb. above the pressure of the atmosphere. Amongst his earliest investigations he made a model of a high-pressure engine, which acted very well; and he described a high-pressure locomotive engine in his specification of 1784; but he considered steam at such a high pressure to be unsafe, and did not make any use of it. His assistant, Mordoch, afterwards made a working model of a locomotive engine which acted very well, but he did not pursue it further. Leupold had proposed a high-pressure engine in 1725; and one was made by Cugnot at Paris in 1770 for propelling a carriage, but it failed entirely, and was never used.

Trevithick and Vivian obtained a patent in 1802, for high-pressure engines, in one of which locomotion was to be produced by the adhesion of the wheels, propelled by the engine working on the road. They also proposed ribbed wheels with nails or bosses, for the purpose of enabling the engine to ascend steep places. In 1804 they made a locomotive engine, which travelled upon the Merthyr Tydvil railway; it consisted of one high-pressure cylinder, with a fly-wheel, and four bearing-wheels, two of which were turned by the action of the piston, and produced a velocity of five miles an hour, drawing after it several wagons, containing a load of about 15 tons. This locomotive worked by adhesion alone. The experiment was not continued, because the weight of the engine, with its cast iron boiler, was considered too great for the rails, and might have occasioned considerable damage to them, and if the weight of the engine had been reduced sufficiently, it would have been too light, and the wheels would have slipped upon the rails. Thus we see, that the great principle of adhesion, for producing locomotion, was clearly understood at the outset, and was only abandoned in consequence of the cast iron plate rails at that time in use, being unfit for carrying it into effect. In addition to the objection on the score of the weight of Trevithick's locomotives, more serious opposition arose against them in consequence of one of them having exploded in 1803. This objection was made to all Trevithick's locomotive engines, although ultimately they came into use. He had made an attempt to propel carriages on common roads by steam in 1806, and constructed a carriage worked by steam, which was exhibited publicly, in the neighbourhood of Bethlehem Hospital. To that ingenious and able man the origin of the locomotive system may be said to be due. In 1811 Blenkinsop took out a patent for using rails, having teeth like a rack in them, into which wheels, having corresponding teeth, were worked by the engine, thus securing the engine against the chance of slipping. This was brought into use for conveying coals from the Middleton Colliery, near Leeds, which may be said to have been the first practical employment of locomotive engines; but the expense, friction, noise, and slowness of the motion, which scarcely exceeded four to five miles an hour prevented it from being generally adopted. In 1813 Brunton took out a patent for producing locomotion by levers, worked by the engine, resembling a good deal the motion of a horse. This however failed, and a serious accident occurred by the explosion of the engine attached to it. Chapman followed, and patented an invention for producing locomotion by means of chains laid along the line of road, passing round the wheels of the locomotive, and thus travelled forward. In 1813 Blackett resumed Trevithick's original plan, and constructed an engine which worked by adhesion alone, upon the rails at the Wylam Colliery, at Newcastle.

George Stephenson in 1814 improved upon all the former locomotives, and took out patents in conjunction with George Dodd in 1815, and with Losh in 1816. The locomotive, in his hands, soon became sufficiently perfect to be brought into general use on railways, for drawing coal wagons at a greater rate than could be performed by horses. The weight of the engine was sustained on the axles of the carriages, by means of small pistons working in cylinders, supplied with water from the boiler, which acted like so many springs. Two steam cylinders were employed, and all the four wheels were impelled by them; the engine was followed by a tender carrying water and fuel. Here was a grand epoch in the history of railways, which were destined at no very distant period to effect such a complete revolution in the whole system of international communication, and to realise such extraordinary results, as even the most sanguine minds never anticipated. James, who had examined the machines, published a letter in 1815, proposing railways as a general system for travelling. The general introduction, in 1816, of the cast iron edge rails, and the flanged wheels, which are said to have been invented by W. Jessop, long before, on the Loughborough railway, instead of the cast iron tram-plates with which the earlier railways had been laid, was soon followed by the introduction of wrought iron rails, in long pieces, at first, in plain rolled bars, and afterwards rolled with projections on their upper edges, in order to give breadth for the wheels to run upon, as well as to increase the strength of the rails and enable them to bear greater weights without yielding. This was the patent invention of Birkenshaw, who made them in 1820. The above were great improvements in the system, and by degrees, all the details were worked out more effectually at the different collieries near Newcastle, and in the North, until the locomotives were so far improved, as to enable them to travel at the rate of seven to eight miles per hour, drawing considerable loads behind them. The Hetton and the Stockton and Darlington railways, by Stephenson, which were opened about 1825, contained all the improvements made up to that time; and the last act of parliament of the latter line authorised the use of locomotive engines.

The Liverpool and Manchester Railway Company obtained their first act in 1826, under the Messrs. Rennie, but the kind of tractive power to be employed was left open for future determination. The railway works, however, proceeded, and considerable progress was made before it was decided what power should be employed. The company employed Messrs. Walker and Rastrick to investigate the different means employed in the North as tractive power on railways, and to report which, in their opinion, they considered best adapted for the railway; upon the whole, they reported in favour of using stationary engines to draw the wagons and carriages. Stephenson and Rennie were in favour of locomotive power. The directors took up the matter with considerable spirit, and offered a reward of five hundred guineas for the best locomotive engine. The competitors for this premium were, Stephenson, Braithwaite and Ericson, and Hackworth and Brandreth. The weight of the engines was restricted to 6 tons, including the water in the boiler, and the load was limited to three times that weight, to be conveyed at the rate of at least 10 miles an hour. A trial of the engines of the three competitors was made on a part of the Manchester and Liverpool railway, in 1829, and the extraordinary speed of between 20 and 30 miles an hour was realised by Stephenson's engine 'Rocket.' So long as the motion upon the rails was produced by the rack and pinion, the greatest velocity attained scarcely exceeded 4 or 5 miles an hour; this was only adapted for the transport of heavy goods, and the expense, except in few situations, precluded it from being extensively brought into use; but the principle of adhesion being established, and 7 and 8 miles an hour obtained, the success of this great invention became evident, and it was predicted that its adoption would be general. Still, however, doubt and prejudice prevailed with many, and amongst them

were some men of no ordinary ability and experience, and it was not until the triumphant success of the great experiment in 1829, that the most sceptical were convinced of the application of the system eventually becoming universal. The scientific world beheld with amazement this extraordinary result, the consequences of which could hardly be foreseen. Springing at once from a velocity of travelling of 10 miles, the greatest speed of coaches, to 25 miles an hour, so far exceeded even the most sanguine expectations of its promoters, that they saw no bounds to its extension.

Stephenson's engine for the competition was upon an improved plan; the boiler contained numerous small tubes, through which the flame, or rather heat, from the fire-box or furnace, was made to pass, thus exposing a greater surface of water for the heat to act upon, and increasing its powers of evaporation. Booth, the indefatigable secretary to the company, has the credit of this great improvement, which is now universally adopted, not only in locomotive, but also in marine boilers. The engine had two cylinders which impelled the wheels, and the waste steam from the cylinder was discharged through a small tube or blast-pipe into the chimney, with a vertical jet, thus increasing the draught of the fire, and enabling it to produce the desired heat in the fire-box. This blast-pipe was a most simple, ingenious, and important invention, which has contributed very materially to the improvement and perfection of the locomotive. The merit of this is claimed by both Stephenson and Hackworth. The boiler and apparatus were supported on the frame by springs, in the same manner as in ordinary wheeled carriages, thus preventing the concussion to which the different parts would otherwise have been subject, and enabled the machine to work with greater effect. The 'Novelty,' by Braithwaite and Ericson, was also a very ingeniously contrived engine. The 'Sans Pareil,' by Hackworth, was an improvement upon previous engines, but did not fulfil the conditions required so well as that of Stephenson, to whom the premium was awarded. Looking back at the result of these experiments, and what has occurred since, it appears injudicious that the weight and size of the engines should have been thus limited; for inasmuch as the power of traction of a locomotive engine depends upon the force of adhesion, which could only be produced by weight, and its capability of generating steam by increased dimensions, by limiting these two elements the power of the engine was necessarily reduced. Upon reflection, however, we cannot be surprised, for nothing but experience could have pointed out beforehand the present extraordinary results.

The Manchester and Liverpool railway was opened in September, 1830, with great ceremony by the Duke of Wellington, Sir Robert Peel, Mr. Huskisson, and an immense concourse of spectators; but unfortunately this great event in the mechanical, commercial, and social world was clouded by the death of that great man, Huskisson, in consequence of a locomotive engine passing over him, thus becoming one of the first victims of that extraordinary invention, of which he entertained so high an opinion. The first engines for this line were made by Stephenson, after the plan of the 'Rocket,' but improved; and in other engines made soon after, he introduced a better arrangement of the parts, giving a greater number of tubes to the boiler, and adapting cranked axles to work the wheels; the first of these was the 'Planet,' which afterwards served as a model for the locomotives on other railways. Great improvements have since been made; heavier engines, weighing from 18 to 30 tons, capable of evaporating 200 to 300 cubic feet of water per hour, instead of 60 cubic feet, as in the early engines, with tenders capable of carrying 1000 to 1500 gallons of water; straight axles, with outside cylinders, like those of the 'Rocket,' have been again introduced, in order to increase the power and to obviate the objections raised against the cranked axles, as to their liability to break; engines, with six wheels instead of four, are now generally approved, as being safer; and those with coupled wheels have been made to increase the adhesion on steep planes. Improvements in the slide valves and working gear have been made for using the steam expansively in the cylinders, and rendering the engines more manageable either for backward or forward movement. The increased size and power of the engines have enabled them to ascend planes of 1 in 37, as on the Gloucester and Birmingham railway, drawing after them heavy loads at considerable velocities, which, at the first introduction of the locomotive, would have been impossible. On that line, at the Lickey incline, engines made in America were at first used.

Laying the Rails.—The mode of making and laying the rails of the permanent way has also partaken of the improvements in the engines; the original rails of the Manchester and Liverpool line weighed only 30 lb. per yard, of the form termed 'fish-bellied,' and, for the most part, were laid upon stone blocks, after the plan of the colliery railways, on which the speed rarely exceeded 2 to 5 miles per hour, but when it was increased to 20 or 30 miles per hour, greater strength was necessary. The concussion produced by such heavy engines and trains, weighing from 50 to 300 tons, travelling at the rate of 20 miles and upwards per hour, soon deranged the light rails, and the concussion produced by the stone blocks rendered the employment of some more elastic medium desirable. Accordingly, heavier rails, parallel in depth, with a rib at top and bottom, were adopted, after the form suggested by the experiments of Professor Barlow, with as much weight as the art of rolling iron could give, until it reached 75 lb. per yard; instead of stone blocks wooden sleepers have been preferred; heavier and improved chairs for supporting the rails, with side keys of hard compressed wood to keep them in their places and resist the concussion, have been adopted; in this latter department Ransome and May have introduced great changes; the sleepers have been steeped in preparations from the patents of Burnet, Kyan, and Bethell, for the purpose of securing greater durability. A variety of plans for making the rails and laying the permanent way on improved methods, have been proposed and tried, such as the bridge or hollow rail screwed down to longitudinal sleepers, which again are screwed to transverse sleepers below them, as adopted on the Great Western railway; the solid rail secured by screws to longitudinal sleepers alone, as adopted on the Greenwich and Croydon lines; the parallel rail fixed to transverse sleepers, as adopted on the Dublin and Drogheda line, and others, all of which require the test of experience before any correct opinion can be formed as to their respective merits. Rails of prepared wood, patented by Prosser, have been proposed for insuring the adhesion of the wheels on steep inclines, but have not been much adopted.

Stone railways or trams, which have been in use in the streets of Milan for a long period with considerable advantage, were employed at the Dartmoor railway, to bring down granite from Dartmouth to Plymouth, a distance of 20 miles; also one of 12 miles in length for a similar purpose from Haytor to Newton; and a more perfect example was completed by Walker between the West India Docks and London, on the Commercial-road, a distance of two miles, in 1826. The tramway is composed of blocks of granite, 4 to 5 feet long, 16 inches wide, and 12 inches deep, nicely squared, bedded, and jointed, and laid in a bed of concrete; it has been found of considerable service in reducing the friction, and enabling horses to draw heavier loads with facility, in ordinary cases.

In addition to the adoption of wooden sleepers, it has in some cases, where great speed is employed, been considered advisable to introduce a layer of india-rubber, or elastic felt, between the rail or chair and the sleeper, in order still further to reduce the concussion, and to render the motion more easy; for now that the extraordinary speeds of 40 to 50 miles per hour have been effected, and are daily employed on the Great Western and other railways, too much care cannot be taken in constructing the works of the railway, and particularly in laying the permanent way; and until this be done it is scarcely prudent to exceed the present high velocities.

Gauge of Railways.—Before leaving this subject, it may perhaps be necessary to make a few remarks upon the width of gauge. This important question comprehends so many elements, that the determination of it is involved in considerable difficulty, and experience alone can afford it satisfactorily. Stephenson, who has taken such a prominent part in the introduction and extension of the railway system, adopted the gauge of 4 feet 8½ inches. Messrs. Rennie proposed 5 feet for the Manchester and Liverpool railway before it was commenced; this, contrary to their advice, was afterwards made 4 feet 8½ inches. Brunel proposed, and carried into effect, 7 feet on the Great Western. The Eastern Counties was originally laid at 5 feet 6 inches, and afterwards altered to 4 feet 8½ inches. The Dublin and Drogheda is 5 feet 3 inches; and the Ulster lines are laid at 5 feet 6 inches. Cubitt now proposes a uniform width of 6 feet throughout the kingdom; the object of all being to ensure the greatest perfection in the engine; as to speed, power of traction, economy of working, and safety in transferring passengers and goods. Taken in the abstract, a broad gauge would appear to afford the means of making more powerful engines, which can draw greater loads with greater speed and safety than a narrower gauge; but then it involves a greater first outlay, and a commercial question arises, is this necessary, when already, upon the narrow gauge, a speed of 60 miles an hour has been obtained with a tolerable load? A greater velocity appears not to be advisable, until the mode of making the road has been improved; and in the mining and manufacturing districts, the narrow gauge is stated to be more convenient and less expensive. Uniformity of gauge, however, is generally admitted to be desirable, in order to avoid the delay, expense, and inconvenience of a change of carriage for both passengers and goods, and it is to be regretted that a broader gauge had not been adopted on the Manchester and Liverpool railway, which might have served as an example to all subsequent lines, and have prevented the difference of opinion which has since prevailed. The gauge of the Great Western is probably greater than is necessary; but as it has already been adopted to a considerable extent, and has certainly realised very extraordinary results, and as it is impossible to foresee what further improvements may result, so as to obviate any inconvenience arising from a break of gauge, it would seem not to be desirable to stop the progress of improvement by altering it now, when it may be the means of creating further improvements in itself, as well as in the narrow gauge system, which might otherwise never be thought of.

Progress of Railways.—The traffic on the Manchester and Liverpool railway far exceeded the most sanguine expectations, and the passenger traffic, which was scarcely reckoned upon as a source of revenue (goods alone being relied upon), increased to such a degree, that it soon superseded every other conveyance between Liverpool and Manchester, and produced a large additional revenue. Notwithstanding, however, its brilliant success, the great cost of the railway, and the remnants of old prejudices against innovation, combined to keep alive the doubts and fears as to the profits which might be expected from other railways, less favourably situated than between two such large manufacturing and commercial towns, depending so entirely upon each other. Hence the numerous projects which were first brought forward met with a great deal of opposition, and did not receive that encouragement which subsequent experience has proved them to be entitled to.

After much delay, several acts of parliament for new lines of railway were obtained, notwithstanding the most strenuous opposition of the ex-

isting interests of canals, roads, land-owners, &c., which was only overcome at enormous costs. Amongst the first of these may be mentioned the London and Birmingham, the Grand Junction, the Great Western, Bristol and Exeter, Southampton, Brigton, Dover, Leeds, York, and others. The prejudices against them have now vanished, and the mania for new lines has of late exceeded all former precedent. 1901 miles have been already executed on the narrow gauge, 274 on the broad gauge: 614 miles are in progress of construction, and projects for 20,687 miles were actually introduced into parliament last session, representing a capital of £350,000,000. Of these projects, acts of parliament have been passed for 3573 miles, requiring a capital of £129,229,767.

In most parts of Europe, railways have already been constructed, or are in progress, or in contemplation, after the plan of those executed in this country. The following names must be borne in mind as associated with the invention and propagation of the railway system,—Barnes, Birkenshaw, Bidder, Blenkensop, Blackett, Booth, Brandreth, Braithwaite, Brunel, Buck, Buddle, Cubitt, Curr, Dodd, Ericson, Giles, Good, Hackworth, James, Jessop, Leather, Losh, Locke, Lambourt, M'Neil, Rastrick, G. and J. Rennie, Reynolds, G. and R. Stephenson, Trevithick, Vignolles, Vivian, Watt, Walker, Wood, and many others.

Steam Coaches. — Great efforts have been made to perfect steam-coaches, so as to enable them to travel upon turnpike roads, but hitherto without much success. The idea was suggested by Robison to Watt, in 1759, and Watt patented it in 1784. Symington proposed it in 1786. Trevithick's patent of 1802 was the first high pressure engine that was actually made, and patents for improvements upon it have been numerous. Bramah constructed a steam-coach in 1822 for Griffiths, which was not successful. Gordon tried one in 1824, and Gurney, who was more successful, constructed some with boilers, having very small tubes; he attained a speed of 10 miles an hour on good turnpike roads, and ascended the steepest hills near London; he went from London to Bath and back, in 1831, and his steam carriages ran for four months between Cheltenham and Gloucester; but it was extremely difficult, and too expensive, to keep them in order. Hancock constructed several with boilers composed of thin metal chambers; they ran for some time, with apparent success; but there were so many difficulties that they did not get into use. Dance, Field, Hill, Macerone, Russell, Cayley and others, also attempted it, with varied success; but the system is inferior to that of railway travelling, and it is now generally given up as hopeless. It has been proposed to employ highly compressed air in place of steam for propelling locomotive engines, first by Medhurst, in 1799, and since by others, but without any trials being made beyond mere models.

Fast Canal Boats.

Attempts were made by Grahame, and others, to accelerate the passage-boats on canals; the mode was extremely ingenious, and at one time was brought into use on the canals in Scotland, the north of England, and other places. The mode was as follows:—A beautifully-constructed boat, whose length was about ten times as great as the breadth, and drawing very little water, was drawn by two horses, commencing at a trot, and soon increasing their pace to a gallop; the boat once put in motion required very little effort to maintain its speed, which was 10 miles an hour, and formed a considerable improvement in canal navigation; increased expedition was also given to the boats for goods, and general speed and economy of charges and improvement in management prevailed. All this, however, came too late, for although it would have been readily acknowledged at an earlier period, and might perhaps, for a while, have retarded the railway system, yet when once the latter was established, its superiority became manifest, and its progress became irresistible. The railway system also gave increased stimulus to improvement in steam-boats, which had been previously in use, and which I shall presently notice more at length.

Taken simply at the velocity of 2½ miles per hour, the resistance or friction offered to the tractive power by a given load is in favour of the canal; but as this resistance increases with the velocity at a far greater ratio on the canal than on the railway, the advantage with increased velocity becomes decidedly in favour of the railway, and inasmuch as the value of time in everything has become more important, so railways must necessarily increase in superiority; besides, as in any case having a large profitable traffic in passengers, which a canal cannot have, the extra power for conveying goods is comparatively very little, so that the competition even in heavy goods, in many cases, is in favour of the railway also. Some canals are now being amalgamated with, or converted into railways, being unable to withstand the competition with the railway.

Stationary-Engine System.

Of the numerous other systems or projects, in addition to locomotive engines and horses, which have been suggested for propelling carriages along railways, two only worth mentioning have been brought into operation, viz., traction by ropes wound round drums or cylinders, worked by stationary or fixed steam engines, and the more recently introduced atmospheric system. Traction by ropes up steep planes had long been in use at the collieries in the North, where what are termed self-acting planes were established, upon which the descending loaded wagons attached to a rope, passing round a pulley-wheel, drew up by their superior gravity the empty wagons attached to the other end of the rope. The same principle was applied by Reynolds to transfer canal-boats from one level to another, in the case of the Ketley Planes, on the Shropshire canals in 1788, also in the subterranean portion of the Bridgewater canal at Worsley, in 1797, and at other places. The system of rope-traction by stationary engines was adopted in the collieries of the North, the steep undulating nature of the country being well adapted for it. Thompson applied the reciprocating system with great success to the Seaham and Durham Junction, and other railways, the lines being a series of successive planes, extending over 8 or 10 miles, without interruption, having fixed engines with ropes actuated by them, so that the traffic was transferred from one plane to another, taking advantage of gravity in the descents. The rope and stationary-engine system was applied to work the steep planes on locomotive railways, which were considered at the time too steep for the locomotives to travel upon; but recently locomotives have been so much improved, and rendered so much more powerful, that they can ascend planes at considerable velocities and with tolerable loads, where formerly it was considered impracticable. Examples of these may be mentioned;—the inclined planes of Edge-hill and Rainhill on the Manchester and Liverpool railway, the Lickey plane on the Gloucester and Birmingham, the Euston-square incline plane on the Birmingham railway, and other places. The most remarkable and successful application of the rope system is the Blackwall railway, by Stephenson and Bidder, in 1840. The line commences at Fenchurch-street, and terminates at the East India Docks, Blackwall, being about 3½ miles long; it is carried upon brick arches above the streets, and at each end, or terminus, there are powerful fixed steam-engines, turning large drums or cylinders, round which the ropes for drawing the carriages are wound at the rate of 25 miles an hour. Each pair of engines at the London terminus, built by Maudslay, is 224 horse power, whilst each pair at the Blackwall end, built by Barnes, is only 140 horse power, the line descending all the way to Blackwall. The plan of accommodating the intermediate traffic is very simple and ingenious; it is effected by attaching the carriages to the rope, by a clutch worked by a lever; this is readily detached by a man on the carriage, whilst the rope is in motion, and answers perfectly. The planes between Fenchurch-street and the Minories are worked by the momentum of the carriages one way, and by gravity the other. This system has its advantages and disadvantages, and is more particularly applicable when the load is regular and constant, so that the full power of the engine may be employed to advantage. The wear and tear of the ropes is very expensive, but has latterly been much diminished, by the substitution of wire ropes for those of hemp.

Atmospheric Railways.

The atmospheric system has been the subject of much discussion here and elsewhere. It was first proposed in 1824, by Vallance, of Brighton, where a working model was constructed of sufficient dimensions for the carriages to be introduced at one end of a tunnel, and the air being exhausted by a steam-engine at the other, they were propelled forward, by the pressure of the atmosphere. It was even proposed to adopt the system for the speedy transmission of letters; the system, however, was necessarily so imperfect, that except for the ingenuity of the idea, it was of no practical utility. It was afterwards improved by Medhurst, in 1827, and was brought forward by Pinkus, in a more complete form, in 1834, by making the carriages travel outside the tube; and in 1839, it was further improved and patented by Clegg; since that period it has been brought into operation by Clegg and Samuda, who tried an experiment upon a working scale, in 1840, for about a mile in length, at Wormwood Scrubbs. This experiment showed that a load of 6 tons could be propelled at a velocity of 30 miles an hour, with an atmospheric tube only 9 inches diameter, and induced the leading proprietors of the Dublin and Kingstown railway, to adopt it, for extending that line to Dalkey, a distance of about 1¾ mile, where the country was difficult, and not well adapted for locomotives. That extension was opened in the latter end of 1843, and has continued working ever since. The line is single; the rails, although rather lighter, are laid upon the ordinary plan, and in the centre between them there is a tube about 15 inches in diameter, having a slit or opening at the top, which is closed by an elastic valve; a piston, fitted to the foremost carriage of the train, is inserted into the tube, which is connected at the upper end with an air-pump, worked by a steam engine, which exhausts the air from the tube, and the piston attached to the foremost carriage is then urged along the tube by the pressure of the atmosphere, and draws the train with a velocity in proportion to the perfection of the vacuum in the tube: as fast as the piston advances, the valve in the slit of the tube is opened, and is closed again after the piston has passed, and is rendered tight and impervious to air by a composition of fatty matter placed in the groove into which the edge of the valve falls. The planes of this line are extremely steep, being in places 1 in 50, and the curves are very sharp. The highest vacuum obtained has been 26 inches, with a speed of 35 miles an hour. The train returns from Dalkey by gravity alone. For a first experiment, it has been tolerably successful. The system is being tried upon a larger scale upon the Croydon and the South Devon railways; a portion of the former has been opened, and a speed of 60 miles an hour has been obtained, with a vacuum in the tube of 27 inches; and a train, consisting of 10 carriages, weighing 50 tons, has been propelled 5 miles in 8¼ minutes, or at the rate of 35 miles an hour, the barometer indicating a vacuum of 25 to 28 inches. The engines are 3 miles apart, and a power of 300 horses is employed for the whole distance. The tube is 15 inches in diameter, and the air-pump 6 feet 3 inches diameter; the steepest plane is 1 in 50. The South Devon line has not yet been tried.

Considering the recent introduction of this system, and the new con-

trivances required in all its details, much has been done; with further experience, it is not improbable but that much more will be effected. Pilbrow, in 1844, patented a modification of the system, which is ingenious, but has not yet been sufficiently tested by experience to prove its merit. Hallette proposed to improve the valve on the top of the atmospheric pipe, by means of two small inflated elastic tubes, fixed in grooves on each side of the opening on the top of the pipe, through which the rod attached to the piston should slide between the tubes, and which should close the orifice as the piston moved. This ingenious idea requires the test of experience.

STEAM NAVIGATION.

The extraordinary improvement in the mode of communication, which has been effected by steam power and railways on land, had been preceded by equally surprising and important effects produced by the application of steam to sea and river navigation. The vast increase of personal intercourse between people of different nations separated by the ocean, which has resulted from this great discovery, and which is still augmenting, has operated more than any other invention on record (not even excepting printing, which has been greatly extended by steam) towards realising what was once considered Utopian—the bringing of the various nations of the world together, and uniting mankind into one great family, working harmoniously together for their common good. The steam engine, in its various and numerous applications, may justly be styled the grand improver and civiliser of the age. It is a gigantic yet docile labourer, equally well adapted for extracting fuel and other minerals from the bowels of the earth, as for performing all kinds of toilsome, complicated, or delicate operations, whether for forging the ponderous anchor and cable to preserve the gigantic vessel of war from shipwreck, or for weaving the most delicate web for a lady's garment. Its power can be increased to almost any extent, and it can be made to perform, with a degree of celerity, economy, and skill, every operation which formerly could be executed by the human hand alone, and an almost infinite variety of others, which without it could never have been attempted. It may also be employed as a means of conveying merchandise and travellers from one place to another, whether for business or pleasure, with a degree of certainty, expedition, convenience, and economy attainable by no other agent. The increase of commerce, national industry, and wealth, as well as greater personal intercourse between nations, serves to dissipate prejudices, and to create reciprocal good feelings towards each other, and thus to promote peace; but if, unhappily, war should ensue, then by the increased facility afforded for attack and defence, steam would equally serve to shorten its duration by rendering the results more decisive, and making mankind less willing to embark in it.

The origin of the application of steam for propelling vessels is claimed by several individuals of different nations; but it is generally admitted that to Great Britain is due the merit of having introduced and established the successful practice of the present age. The application of wheels to propel boats dates as far back as the Romans; in 1682, Prince Rupert's barge was propelled in a similar manner, and tug vessels, with wheels worked by horses, for towing vessels against wind and tide, were proposed. Papin proposed, in 1690, to propel boats by racks and pinions with pistons working in steam cylinders; Blasco de Garay, a Spaniard, is said to have made an experiment on propelling a vessel in the presence of the Emperor Charles V., at Barcelona, in 1543. The experiment is reported to have succeeded, and received the approbation of the emperor, who paid all the expenses. The invention, if it existed, died with the inventor, and nothing further was heard of it, until after the introduction of steam navigation, when the statement was made in order to claim for Spain the merit of this great invention. Had this claim been brought forward earlier, and published to the world, it might perhaps have been allowed; but appearing at this time, it could have no influence, and must clearly be regarded as in no way interfering with the title of Great Britain to the discovery. Jonathan Hulls, in 1737, published a small pamphlet, wherein he gives a plate representing a boat with a wheel attached to the stern, driven by a steam engine to propel the boat, and tugging behind her a vessel of war. This is clearly the first representation on record of a steam boat. He took out a patent for the invention; but experienced so much opposition from prejudice, that he does not appear to have prosecuted it afterwards. Hulls proposed to apply Newcomen's engine for propelling the wheel, but as it was very difficult to produce rotatory motion with that kind of engine, that may have been one reason why it was abandoned. Savery proposed, in 1698, to apply manual power to the capstan of a ship, by the intervention of a wheel and pinion for turning paddle-wheels attached to the sides of the vessel; and, at a later period, Captain Burton proposed a similar plan. All idea, however, of bringing the invention to bear appears to have been laid aside until 1765, when the mechanical and scientific world had again turned their attention towards the improvement of the steam engine, and Dr. Robison, of Edinburgh, proposed to Watt to apply steam for propelling vessels on land and by sea. Watt, however, at that time had not made sufficient progress with his invention, to enable him to take up and work out the idea with sufficient prospect of success, as it is evident that he could not have considered Newcomen's engine at all calculated for the purpose; Watt, therefore, confined his views to perfecting his engine, foreseeing, no doubt, that when once that end was accomplished, other important results would follow.

The subject of steam boats still lay dormant for a time. In 1782, the Marquis de Jouffroi is said to have made a steam boat, 140 feet long and 15 feet wide, which was tried on the Seine at Lyons, but it was not successful. About the year 1787, Watt had so far perfected his steam-engine, and rendered it capable of producing rotatory motion, as to enable it to turn mills: he had thus overcome one of the principal difficulties, and prepared the way for the introduction of the modern system of steam navigation; but although numerous attempts were made with imperfect engines for propelling vessels, even after Watt had obtained patents for his improved engines, yet it was not until after the expiration of his patent for the rotatory engine, in 1800, that it was applied to steam vessels.

About the year 1788, Fitch and Ramsey, of America, and Serratti, of Italy, appear to have tried some experiments, and thus they lay claim to the invention, but upon this point there is no accurate information. In the same year, Miller, of Dalswinton, constructed a double boat, 60 feet long, with two paddle-wheels in the centre, to be moved by manual labour, in order to race with another boat propelled by oars in the usual manner; it was tried upon the sea near Leith, when Miller beat his competitor, and the effect of this experiment convinced him, that power only was wanting to bring the invention to perfection. Taylor proposed to apply the steam engine for this purpose, and he then applied to Symington, a practical engineer of the day (who had previously proposed some improvements in Newcomen's engine, and had made a model showing how it might be applied for the purpose of propelling carriages), in order to assist him in applying the steam engine for working paddle-wheels. A steam engine with two cylinders, 4 inches in diameter, each of about one-horse power, was accordingly made by Symington and Taylor, and was applied to drive the paddle-wheels in the centre of the double boat, employed for pleasure on Dalswinton Lake, in the middle of October 1788, when it attained a velocity of about 3 miles an hour. The success of this experiment was complete as far as it went, and established beyond doubt the merits of the discovery; it therefore induced the ingenious and persevering projectors to prosecute it further by making another vessel of the same dimensions as the former one, to be worked by an engine on a larger scale. The engine was made at Carron, and was of a peculiar construction, in order to avoid infringement on Watt's patent; it had two atmospheric cylinders of 18 inches diameter, the pistons of which were connected with a lever acting alternately and by means of chains; pulley-wheels and ratchets turned two paddle-wheels, one being placed before the other, in the space between the two parts of the double boat. This machinery, it will be observed, was similar to Hulls's plan; improved, however, by having two cylinders. The boats and engines were completed, and the experiment was tried on the Forth and Clyde canal, on the 26th December, 1789, and was still more successful than the first, having attained a velocity of 4 or 5 miles an hour. An account of this experiment was published in the Edinburgh newspapers of the day. The signal success of this second steam boat rendered further experiments unnecessary, and it now only remained to bring it into practical operation. Messrs. Miller, Symington, and Taylor had proved to the world the merits of the discovery, and not wishing to incur further expense or trouble in combating the prejudices and opposition of mankind, which invariably obstruct the introduction and prosecution of every great invention, did not prosecute the subject further, but left it to others to work out and develop the powers of their extraordinary invention, which was destined, at no distant period, to produce such a wonderful revolution in the social world. The engines and machinery were accordingly taken out, and deposited at the Carron Works, and the boat, which was only a pleasure-boat, and fit for no other purpose, was transferred back to the lake of Dalswinton, and again applied to its original purpose. Mr. Miller returned to his agricultural pursuits; Taylor to his profession of a tutor; and Symington to his profession of a practical engineer.

In 1793, Ramsay made some experiments for propelling a vessel by forcing water out of the stern by a steam engine: this does not appear to have answered.

In 1795, Earl Stanhope, well known for his mechanical genius, tried an experiment for propelling a vessel, by means of a propeller in the form of a duck's foot; and about the same time Smith fitted a boat with an atmospheric engine on the Sankey Canal; none of these experiments, amidst several others which were tried, appear to have been very successful; the great difficulty seems to have been in producing the rotatory motion by the steam engine employed for the purpose, and it is singular that none of them tried Watt's engine, which had then become generally known, and Boulton and Watt themselves were too busy in making their engines for the numerous mills and waterworks then becoming daily more general, to turn their attention to fresh speculations, the issue of which was at that time doubtful, and which did not promise to be so lucrative.

In 1801, Lord Dundas, who took great interest in mechanical pursuits, employed Symington to construct a steam boat; this was propelled by an engine on Watt's plan, having one cylinder placed horizontally, and the piston, with a stroke of 4 feet in length, was jointed at the extremity, and attached to a connecting rod, with a crank at one end, turning a paddle-wheel, placed in a well-hole at the stern of the vessel, which had two rudders, one on each side of the cavity in which the paddle-wheel was placed. This was the first practical working steam vessel with an engine on Watt's system, and was called the 'Charlotte Dundas;' it was employed for towing vessels on the Forth and Clyde canal, and answered its purpose completely, but the proprietors of the canal objected to its being continued, in consequence of the agitation of the water produced by the paddle-wheels, which they alleged would injure the banks of the canal.

In 1802, Fulton, who had been some time in England, hearing of Symington's attempts, went to Scotland, visited him on board his boat, and requested to see it tried. Symington accordingly got up the steam, made several trips up and down the canal, and fully explained to Fulton every part of the boat, steam engine, and apparatus. Fulton made notes of everything, observing at the same time, that the objection of injuring the banks of the canals and small rivers might apply in England, but that in America, where they were upon a much larger scale, this inconvenience could not be felt, and he thought the application of steam boats in that country would be of immense public and private advantage, and stated his intention of introducing them there. After this visit to Symington, Fulton proceeded to France, where he constructed his first steam boat, and tried it on the Seine, at Paris, in 1803, and proceeded to America soon afterwards. It is rather singular that Napoleon, who was then First Consul, and who usually was alive to all great improvements, and carried them through with a degree of energy and talent which overcame all opposition, should not have appreciated the merits of the steam boat, and should have allowed such a fine opportunity of benefiting France to have slipped through his hands; but perhaps the same may be said of England, as being still more extraordinary, for the advantages of the steam engine and machinery had then become universally acknowledged. Fulton, however, impressed with the importance of the invention, and being thoroughly convinced of its ultimate success, pursued it with unremitting perseverance and energy, and in 1805 he applied to Messrs. Boulton and Watt to make a steam engine for a boat which he was about to construct in America: this boat was accordingly built in 1807. Watt's steam engine reached America in 1806. The vessel was named 'The Clermont,' from his friend Livingstone's residence; the wheels and machinery were on Symington's plan, propelled by Watt's engine; the boat was tried on the Hudson river, and only attained a speed of 5 miles per hour. This was the first steam boat used in America, and Fulton and Livingstone then took out patents for introducing steam boats in various places in America, and built several others upon a larger scale, for carrying goods and passengers, employing Messrs. Boulton and Watt to make the steam engines, which were sent from England, each succeeding engine being larger than its predecessor. Although it was generally known that the steam boats had succeeded perfectly in America, and that their employment was daily increasing, yet little or no attention was paid to the subject in England. The idea of employing steam boats on the ocean had never been conceived, and the objections raised to the agitation of the water by the paddle-wheels on the Forth and Clyde canal were considered so strong, that doubts were generally entertained as to the success of the system anywhere but in large rivers, such as those of America. In 1812, however, Henry Bell, of Glasgow, who was well acquainted with, and had deeply considered all that had been done by Symington, determined to try once more whether the invention could not be applied on the Clyde; he accordingly caused a small boat of 25 tons burthen to be built at Port Glasgow, by John Wood, who has since become so well known as a ship-builder; it was 40 feet long, with 10 feet beam, and in it was placed a steam engine of 4 h.p., on what was termed the bell-crank principle, introduced by Watt; the boiler was placed on one side of the vessel and the engine on the other, with four paddle-wheels worked by the intervention of spur gear; the wheels consisted of detached arms, with paddles or floats at the end, which, however did not answer, and the complete wheel, according to Symington's plan, was subsequently adopted. This steam boat, which was called the 'Comet,' began to ply for goods and passengers on the Clyde, between Glasgow and Helensburgh (Bell's native place), in January, 1812, and attained the speed of 5 miles an hour. The 'Comet' succeeded so well, that Bell determined to build another vessel of larger dimensions and power. Numerous other parties, seeing the success which had attended Bell's exertions, determined to follow his example, and several other boats were built during the succeeding years of 1813 and 1814; they were however, still very imperfect, until Cook, of Glasgow, in 1814, constructed the fourth vessel, the 'Glasgow,' with an engine of 16 h.p. The machinery of this vessel was so much more perfect and powerful than any which had been previously constructed, that it served as a model for many others; and from this period steam boats for river navigation were completely established.

Many of the engines employed for the above-mentioned vessels were upon the bell-crank principle; which, from their simplicity and portability, standing upon an independent frame, with the condenser forming part of it, were well adapted for steam boats, and were consequently generally used. The bell-crank levers, receiving the motion direct from the piston, communicated it by means of a connecting rod and crank to the main shaft, turning the paddle-wheels on each side of the vessel; the engine was placed on one side of the vessel and the boiler on the other. The boilers generally used were upon the principle proposed by Allen in 1730, and by Smeaton in 1765, having an internal furnace and flue, surrounded by the water. This form of boiler was first brought into use by Trevithick in 1803, for high-pressure engines, and for low-pressure engines, also, in one of the earliest steam-dredging boats, employed at Portsmouth dockyard, under Beotham; but the exterior shell of this boiler was of wood, as proposed by Brindley in 1758; in steam vessels the external shell of the boiler was made of wrought iron. All the steam vessels above-mentioned were worked by one engine only. In 1814, Boulton and Watt first applied two engines, connected together, for working a small boat on the Clyde.

In 1815, a small vessel, with a side-lever engine of 14 h.p., by Cook of Glasgow, made a voyage from Glasgow to Dublin, and round the Land's End to London; it then ran between London and Margate with passengers with considerable sucess, and this led to others being established in various places; the Scotch boat serving as a model.

In 1816, Maudslay made a pair of combined engines, each 14 h.p., applying the power to the paddle-wheel shaft by the crank, instead of by cog-wheels, according to the previous mode.

In the same year, the late Mr. Baird constructed a steam boat at St. Petersburgh, with a boiler set in brickwork; this boat worked for some time on the Neva.

In 1817, Boulton and Watt purchased a small steam boat called the 'Caledonia,' which had been built in the Clyde, with very defective engines. James Watt, jun., having constructed a new pair of combined engines on the side-lever principle, of 14 h.p. each, made a great number of experiments with the 'Caledonia,' and went with it to the Scheldt and other places; the arrangement of the engines, as improved by Watt, served as a model for several other vessels.

In 1818, David Napier caused the 'Rob Roy,' of 90 tons burthen, to be built by Denny at Dumbarton, with an engine of 30 h.p., with which he successfully established a regular communication between Greenock and Belfast: this may be said to be the first time that a regular communication by steam boats, between two distant sea-ports, was established, and it set the example to every other place. Boulton and Watt, after the success of the 'Caledonia,' made a great number of marine engines of increased power, and with various new improvements, such as introducing wrought iron instead of cast iron for several of the moving parts; and in 1821, a great step was made, by establishing steam boats between London and Leith. Two of these vessels, the 'James Watt' and the 'Soho,' with engines of 120 h.p., by Boulton and Watt, were the largest which had been made, and answered very well.

In 1819, the 'Rob Roy' left the Belfast station, and was transferred to the English Channel, to run between Dover and Calais. About this time Napier built the 'Talbot' of 150 tons, with two engines of 30 h.p. each, which ran regularly between Dublin and Holyhead. In this year also, the late Mr. Rennie, who had for some time previous watched the progress of this great invention with considerable interest, foreseeing that it would ultimately supersede all others, proposed to the Admiralty to use steam vessels for towing vessels of war into and out of harbour against wind and tide; being perfectly satisfied that if once it was introduced into the navy, it could not be long before steam vessels of war would follow; great doubts, however, as to its success were entertained and expressed by many of the official subordinates. Lord Melville and Sir George Cockburn, however, overruled all objections, and, as a first experiment, they consented to allow the 'Hastings,' a 74 line-of-battle ship, to be towed from Woolwich by the 'Eclipse,' a Margate steam boat of 60 h.p. The 'Eclipse,' however, proved too weak, and after towing the 'Hastings' a few miles, it returned, and the 'Hastings' went to Chatham with her sails alone; the experiment was thus not quite so successful as could have been desired; nevertheless Rennie still determined to persevere. Oliver Lang, the master-shipwright of Woolwich Dockyard, entered fully into Rennie's views, and warmly assisted by every means in his power the introduction of steam vessels into the navy, contrary to the opinions of many of his superiors. At length the Admiralty, at their recommendation, ordered the 'Comet' to be built according to the draft and plan, and under the superintendence of Mr. Lang; she was 115 feet long and 21 feet wide, drawing 9 feet of water, and a pair of engines of 40 h.p. each, were ordered for her from Messrs. Boulton and Watt: this was the first steam vessel in the navy, and it is still in use. By degrees several others were built.

In 1820 a steam tug was built by Manby, for Messrs. Smith, for the purpose of towing their barges upon the Humber; and in the same year, Maudslay and Field applied the expansive action of steam in the cylinder, which was a great improvement; also escape valves for the water, which might boil over into the cylinders. In that year also, steam packets were introduced on the post-office station between Holyhead and Howth; and the 'Britannia,' with oscillating engines, and several other steam packets, were built by Manby for the Dover and Calais station.

In 1825, the General Steam Navigation Company was established by William Jolliffe, who built two of the largest vessels which had yet been tried, called the 'George the Fourth' and the 'Duke of York;' they were between 500 and 600 tons burthen, and had engines of 130 h.p., furnished by Messrs. Jessop of the Butterley Iron Works: these two vessels were intended to establish a regular communication between London and Cadiz and London and St. Petersburg; they accordingly started in September 1827, and answered extremely well, notwithstanding the heavy storms which they encountered in the Bay of Biscay and in the Baltic. The General Steam Navigation Company, considering the ideas of Jolliffe too extended, parted with the two vessels (which were afterwards purchased by the Government), and limited their views to the British Channel and the German Ocean. About this period, the 'Enterprise,' of 500 tons burthen, which was built by Gordon, and had a pair of combined engines of 120 h.p. constructed by Maudslay and Field, made the voyage from London to Calcutta, by the Cape of Good Hope. The advantage and superiority of steam vessels, in every respect, for both river and sea navigation, having been now thoroughly established, their employment became universal; and the size, power, and number of the vessels increased daily in every part of the empire.

From this period nothing remarkable appears to have occurred, until the construction of the 'United Kingdom,' which was by far the largest in

size and the most powerful that had been made. She was 160 feet long, 26½ feet beam, and 200 h p.; the vessel was built by Steele, of Greenock, and the engines by David Napier. As deep-sea navigation by steam advanced, it became an object of considerable importance to save fuel, and to obviate the inconvenience of the incrustation of the boilers by the deposit of salt, and other sediments occasioned by the use of sea water; David Napier therefore introduced the system of surface condensation, the condenser being made of a series of small copper tubes, through which the steam, after being used, passed from the cylinder to the air-pumps, the pipes being surrounded by a constant supply of cold water, so that the steam was condensed and the water was returned directly back into the boiler, to be again converted into steam, without the admixture of salt water according to the usual plan, thus employing the same fresh water over again, whereby the above-mentioned inconvenience of incrustation of the boilers was in a great measure avoided. Hall afterwards tried the same system with certain modifications, and it was employed in several vessels; but like Watt, Cartwright, and others who had tried it, he found the condensation was not so complete, and the weight, and cost, and difficulty of keeping the apparatus in order, has hitherto prevented it from being generally used; for although it possesses advantages in many respects, still upon the whole they do not counterbalance the disadvantages, and the old system of condensation by jet, with the aid of the brine pumps, is more generally employed. The brine pumps and refrigerators were invented and patented by Maudslay and Field in 1825, and were used on board the 'Enterprise.' After the 'United Kingdom,' numerous vessels of similar and even greater size were constructed, to ply between London and Leith, Glasgow, and Liverpool, and elsewhere.

The next great step in advance was the crossing the Atlantic. This had long been in agitation, and was freely discussed by numerous enterprising minds, anxiously bent upon working out the fulfilment of such a desirable and important object; but the great practical difficulties involved in the execution were not so easily overcome.

To construct a vessel of sufficient size, with engines of adequate power to propel her through the storms of the Atlantic, and carrying with her sufficient fuel to keep the engines in motion, was considered by many (and among them were very competent authorities) to be extremely doubtful, but by the world in general the task was considered to be wholly impracticable. To Bristol is due the origin of this great undertaking, and a company of enterprising individuals, with Brunel, as their consulting engineer, was formed for that object; it was, however, with difficulty that they found engineers to carry it into effect, some of the first constructors of the day having declined to undertake it. Messrs. Maudslay and Field, however, who had already taken such a prominent part in the prosecution of steam navigation, saw their way, and boldly engaged to construct engines of the requisite power, well adapted for the purpose. Accordingly a vessel, called the 'Great Western,' was designed by Paterson, and built by him at Bristol; and the engines were completed and fitted on board in March, 1838. The vessel was 210 feet long, and 38 feet beam, drawing 15 feet when laden, being 1240 tons burthen, and capable of carrying 500 tons of coals, which it was calculated would last twelve days. The engines were upon the side lever principle, each of 210 h.p., with cylinders 73 inches diameter and 7 feet stroke, making 15 strokes per minutes; they were fitted in cast iron frames, with the latest improvements. The boilers were constructed with the flues over the fires; they were called double-story boilers, and have been since much used; they had brine pumps, and were worked under a pressure of 5 lb. per square inch; the total weight of the engines and boilers, including the water and the paddle-wheels, was about 420 tons The vessel was completed with her engines, and made her first trial on the Thames in March 1838, realizing 12 miles per hour. On Sunday, 8th April, she started on her first voyage from Bristol, under the command of Captain Hosken, with seven passengers, and a cargo of 50 tons of goods, besides 500 tons of coals, and reached New York on Monday, 23rd April, a distance of 3000 miles, in thirteen days and ten hours. Her arrival created the greatest interest; the quays were crowded with spectators, anxiously waiting to give a hearty welcome to the enterprising and successful adventurers, who had thus so triumphantly solved the grand problem, and had brought the New World within a few days' sail of the Old. On her return she left New York on the 7th May and reached Bristol on the 23rd, with 70 passengers; performing the voyage in 15 days. The success of this voyage across the Atlantic having exceeded the most sanguine expectations of its promoters, and indeed of the whole world, there seemed no bounds to the extension of steam navigation; other companies were projected and numerous larger and more powerful vessels were designed, in equal confidence of success; then followed the 'British Queen,' by Napier, of 500 h p., the 'Liverpool,' of 500 h.p., and the 'President,' of 600 h.p., whose melancholy fate served for a time to damp the ardour of speculation. The practicability of steam communication across the Atlantic having thus been established, and its superiority over the old sailing system being clearly proved, time only was necessary to render it perfect. The line from Liverpool to Boston was then designed, and carried into effect by Cunard, for conveying the mails; it consisted of four fast vessels, the 'Acadia,' 'Caledonia,' 'Hibernia,' and 'Cambria,' of about 1000 tons and 450 h.p. each. This was followed by the gigantic project of the Royal Mail Company, for carrying the mails between England and the West Indies, consisting of twelve vessels, each of about 1200 to 1300 tons burthen, and 420 h.p. The engines of these vessels resembled very much those of the 'Great Western,' whose complete success induced their being taken as models for others. The great weight and space occupied by these engines, being upon the average about a ton for every horse-power, rendered it difficult for them to carry any great amount of cargo beyond the passengers, and thus the profits as a mercantile speculation were materially lessened; it became extremely desirable, therefore, to ascertain whether engines, equally efficient, could not be made of less weight, and to occupy considerably less space.

In order to effect this object, engines were invented, by which the power was applied directly from the piston to turn the paddle-wheel shaft, without the intervention of side levers; these were called direct-acting engines, and at first great objections were made to them in consequence, as was asserted, of the loss of power arising from the obliquity of the action of the piston-rod upon the crank on the paddle-wheel shaft. Messrs. Seawards were among the first to introduce this system into the 'Gorgon,' and notwithstanding the objections above stated, it has been improved by them and by other engineers, and has materially gained ground. The obliquity of action of this system, compared with that of the side lever system, can only be considered in the light of a little extra friction, which is fully, if not more than compensated for, by the reduction of weight and space. The modifications of the system by Miller, have been very successful, and combined with the forms of vessels adopted by him, have enabled great speed to be attained both by sea-going vessels, and his boats on the Rhine and other rivers. Even the objection of extra friction, however, if tenable, is obviated by the vibrating cylinders described in Trevithick and Vivian's patent in 1802; patented by Witty in 1813, and by Manby in 1821, by whom the first engines of the kind were constructed; subsequently improved by Maudslay and Field, and Spiller; and now extensively manufactured by Penn, Miller, and others; Maudslay and Field's double cylinder engines, so arranged that a long connecting rod is obtained by its being enabled to descend between the cylinders; the Trunk engine by Humphrey; and the modification of the concentric cylinders by Joseph Maudslay; as well as other varieties of this system by different makers. The substitution of wrought iron for cast in a large portion of the frame and condensers; the tubular instead of the common flue boiler, first proposed by Blakley in 1761, and afterwards improved in the locomotive boiler, and introduced into steam vessels by Maudslay, Spiller, Bramah, and others about the year 1829, as well as the use of steam of higher temperature and increased expansive action, have combined materially to increase the effect of the engines, and reduce the consumption of fuel; so that the space and weight occupied by them is now reduced to nearly one-half what it was originally, or in other words, engines of double the power now only occupy the same space and tonnage in the vessel; thus a material advantage has been gained in enabling vessels to carry a larger quantity of fuel, by which they can extend their voyage; and greater power is rendered disposable for propelling the vessel through the water. As economy of time becomes daily more important, every means which can effect it are brought into operation, and thus the power of the engines has been continually augmented, in order to produce greater speed and shorten the duration of the voyages. Referring to the navy, we find, that in 1822, 80 h.p. was the largest; in 1827, 160 h.p.; in 1828, 200 h.p.; in 1830, 220 h.p.; in 1838, 440 h.p.; and in 1845 we have the 'Retribution' and 'Terrible,' with nearly 1000 h.p. in each, and it is not improbable that, ere long, greater power will be employed.* Whilst the royal steam navy has been making such rapid progress, the mercantile steam navy has not only kept pace with it but has even led the way; for the enterprising, commercial spirit of this country is ever on the alert; every improvement is seized upon with avidity, and the greatest inducements are held out to make new discoveries, in fact nothing but constant progress can satisfy the restless spirit of improvement. In the infancy of the art, we were satisfied with 5 or 6 miles per hour, now, when we have attained above 17 miles per hour, we are confidently looking to a still greater result.

Whilst the improvements, above described, have been making in the engines and in the mode of applying them, various attempts have been made to obviate the inconvenience and loss of power occasioned by the concussion of the floats of the ordinary paddle-wheel entering the water, as well as the heavy drag or back action of the water when the floats leave it; numerous experiments and inventions have been tried for constructing a wheel, of such a form that the floats shall always enter the water in the most advantageous manner, and having effected the object, shall leave it again with the least resistance. To describe the numerous inventions of this kind would be foreign to my purpose, and would occupy too much of your time; it will suffice to mention that of Buchanan, by which the floats always enter and depart from the water perpendicularly; those of Cavé, Oldham, Morgan, Perkins, Seaward, and Barnes, which are modifications of it, differing chiefly in the angle at which the floats enter and leave the water, and the mechanism attached to the wheel by which the motion is communicated to the float-boards; the principle of this invention is extremely good, but in practice it has unfortunately been found, that the wheels of this construction, after a little use, are liable to get out of order; it is not therefore generally adopted, although, whilst they are in order, considerable advantage is doubtless gained. To obviate this inconvenience, as well as that of the common wheel, Field invented what is technically termed the Cycloidal Wheel; this consists in dividing each float-board into several parts or narrower boards, and arranging them so nearly in cycloidal curves that they shall all enter the water at the same place in immediate succession; as the acting force of each board is radiating, it propels whilst

* The total amount of steam power employed in the Royal Navy is about 35,000 h.p.

passing under the water in the ordinary way, and when it emerges, the water escapes simultaneously from each narrow board; this principle was not followed up by its inventor, and was afterwards patented by Galloway, since which it has been very generally adopted. The principle of reefing the paddle-wheels is also used, so that when the vessel is deeply immersed, the leverage of the paddles can be shortened, and when light, it can be lengthened, and can thus be always adjusted to the power of the engines.

As economy of fuel is an object of the greatest importance, so in long voyages it is advisable to employ the wind as a moving power, as much as possible, when favourable: it became therefore desirable to contrive a simple means of detaching the paddle-wheels from the engines, so as to allow them to turn round with the motion of the vessel through the water, and thus to prevent them from impeding her way; various contrivances of this kind have been invented, but one of the most simple, and which is now much employed, was invented by Braithwaite and Milner; it consists of a friction clutch attached to the paddle-shaft, which, by means of keys and screws, can be tightened or slackened with facility, and thus the paddle-wheel is attached or released at pleasure. Numerous attempts have been made to introduce the rotative engine without pistons, but they have hitherto not been successful.

The great results rendered by steam navigation induced the mechanical world to turn their attention towards the extension and improvement of it; Boulton and Watt, Maudslay, Field, Robert and David Napier, Jessop, Glynn, Barnes, Miller, Ravenhill, Girdwood, Manby, Spiller, Scott, Sinclair, Caird, Todd, Fawcett, Bury, Forester, Seaward, Penn, Fairbairn, Hall, Rennie, and numerous other able men devoted their minds to it, and have produced some splendid examples of engines and mechanism in that department. When we look back to Symington's original engine, in 1788, it appears to have been so changed as scarcely to be recognisable as the same, and from a speed of 5 to 6 miles an hour in smooth water, we now find that a speed of 8 and 9 miles an hour against a heavy gale and head wind in the Atlantic, and above 17 miles in still water, has been obtained, whilst improvements are in progress which lead us to anticipate at no very distant period far greater results; much of this, no doubt, is due to the perfection of the workmanship, as well as to the more correct proportions and adaptation of the various parts of the machinery, compared with what was formerly done, and which it was impossible to accomplish with the slender and inefficient means then at command; for this we are greatly indebted to the improved self-acting tools of Whitworth, Fox, Lewis, Sharpe, Roberts, Nasmyth, and others. The improvements in the form and construction of the vessels have also contributed much; and in the investigation of this difficult subject we are much indebted to John Wood, Oliver Lang, Fearnall, Fincham, Ditchburn, Symonds, Rule, Seppings, Scott, Russell, Edye, Patterson, White, Pasco, and others.

(To be continued.)

REGISTER OF NEW PATENTS.

PAPIER MACHE ORNAMENTS.

Charles Frederick Bielefield, of Wellington-street, Strand, papier maché manufacturer, for "*Improvements in the making moulds, or dies, used in the manufacture of papier maché and other matters, and in moulding or forming articles from certain plastic materials.*"—Granted July 14, 1846; Enrolled Jan. 14, 1847.

The invention relates, first, to improvements in making moulds or dies used in the manufacture of papier maché and other matters, and to improvements in moulding or forming articles from certain plastic materials. Secondly, to moulding or forming mouldings from certain plastic materials on wood.

The first part of the invention consists in the application and combination of certain matters hereafter mentioned, for making moulds or dies used in the manufacture of papier maché and other matters, by moulding or forming them therefrom. The materials are as follows:—tanogeletin, sulphur-balsam, gum-thus, and gutta-percha, with a suitable solvent of gutta-percha, preferring Venice turpentine. Gum-thus and gutta-percha are matters imported into this country, and are well known. Tanogeletin is prepared by mixing a solution containing tannin with a solution of glue or animal jelly, of about 36 parts of tannin and 64 of gelatine. Sulphur-balsam is a preparation of a solution of sulphur in fixed oils, mostly prepared with sulphur and linseed oil, and usually consists of two ounces of flour of sulphur and eight ounces of linseed oil, mixed, heated, and stirred, till the sulphur dissolves. In making the moulds or dies above mentioned, mix, dissolve, or combine tanogeletin in Venice turpentine; to this solution add cuttings of gutta-percha, and melt them by means of heat, preferring to use a pug-mill heated by an external steam bath for such purpose. These materials so combined may consist of various proportions of the ingredients, depending on the manner the combinations are to be used in making moulds: the following proportions are preferred,—nine parts by weight of tanogeletin dissolved in eighteen parts by weight of Venice turpentine, adding four to five parts of gutta-percha; this produces a plastic mixture which, whilst it remains warm, may readily be fashioned by placing it on the form from which it is desired to make a mould or die, or it may be pressed into a hollow figure to take an impression therefrom, or made into piece moulds; and when the combined matters have been allowed to remain till they have become cold, the combination of materials will have become hard, and may be used for various purposes, for dies or moulds, for making articles in papier maché and other materials. By adding a small quantity of glycerine, especially where little or no sulphur-balsam is employed, it will be retained longer from becoming hard. For very hard moulds or dies, capable of sustaining considerable pressure, mix with such combinations fine iron filings, using as much as possible so long as the combinations will retain a plastic state, and allow of being readily used, by being pressed into moulds, or into figures or models. White and red lead, and oxides of some metals, such, for instance, as oxides of iron in the state of powder, may be used for giving hardness to the compounds, taking care that they are not added to such an extent as to destroy the plastic materials of the combinations. Gum-thus and sulphur-balsam may be combined with gutta-percha without using the tanogeletin, by means of heat, and the effects of combining these two ingredients is, to produce a very plastic compound suitable for forming moulds or dies (by pressing them on or into suitable dies, surfaces, or models) for various purposes, and the same will be hardened and modified by using other ingredients, as before explained. And sulphur-balsam may also be combined with gutta-percha by heat, and will produce a plastic compound more or less fluid when hot, according to the quantity of sulphur-balsam used, and the same may be employed in taking impressions from models or surfaces (by pressing the same on or into suitable surfaces), and such impressions will be applicable as moulds for making articles from other plastic materials pressed therein. And such combination of sulphur-balsam and gutta-percha may be combined with the other materials above mentioned for hardening them.

When mixing the above mentioned materials, aided by heat, it will be necessary to heat or grind them by machinery, to make them blend intimately together. The first part of the invention also consists in employing the above mentioned combinations of materials as plastic preparations, to be moulded or formed in order to produce articles therefrom in any suitable moulds or dies for architectural and other ornaments and other uses; and owing to the peculiar properties of such plastic preparations they will be found highly useful, for they will take and retain very sharp impressions, which, when set and dry, will not be readily injured, and moisture will not have so prejudicial an effect on articles moulded from such compositions as on many other plastic preparations moulded into articles for like purposes; and such combinations, particularly where it is desired to give tenacity thereto, will be benefitted by having paper-makers' rag dust, or other fibrous material, ground or mixed therewith, and where pliability is desired to be given to the combinations above mentioned, glue may be mixed in quantities according to the degree of pliability desired to be obtained for the particular purpose to which the combination is to be applied.

The second part of the invention consists in forming mouldings for architectural purposes, by spreading gilders' preparation (glue or size and whitening) by means of gauges, on to wood, and then subjecting the same to the pressure of dies to emboss them. In making mouldings, it has been usual to prepare the wood mouldings to the contour desired, and to lay on a succession of coating of the gilders' preparation, and then by rubbing the surfaces thus prepared, the same are rendered smooth. In place of this process, the gilders' preparation is to be used somewhat thicker than heretofore, so that it will be suitable for making a substantive coating at once, and is then to be laid on to the wood moulding by means of a gauge. In performing this process, a sheet-metal gauge is fixed on a bed in such manner that a prepared wood moulding may pass under it, leaving a space between the gauge and the wood moulding, according as it is intended to have the preparation spread more or less thickly; and on one side of such gauge there is a hopper containing the plastic preparation usually employed by gilders, or printer's composition (glue and treacle) may be mixed therewith, to give elasticity or slight pliability to the surface. The wood mouldings pass under the hopper, which is heated by steam to keep the plastic material in a working state, the wood moulding being caused to slide on a long bed, by which it will become covered with the preparation. The wood mouldings being thus coated, are, when dry, to be subjected to the pressure of dies to emboss the surfaces thereof, and for this purpose the use of the roller dies is preferred.

In carrying out the first part of the invention, the plastic materials may be rolled out into sheets or strips, and then embossed and moulded into suitable forms for mouldings, or such plastic materials, or after having been first spread on wood mouldings in the manner described in respect to gilders' preparation, may be subjected to dies in like manner to be embossed.

LOCOMOTIVE ENGINES.

ELIJAH GALLOWAY, of Buckingham-street, Strand, Middlesex, engineer, for "*Improvements in locomotive engines.*"—Granted April 18; Enrolled October 18, 1846. *With Engravings, Plate* IX.

In constructing locomotive engines for railways, it has heretofore been usual to give motion to two or more of the wheels which carry the engine and it has been proposed to apply a central rail to a railway and to employ rollers on either side, pressed towards each other by a hand lever, and motion was communicated to one of them from the axis of two of the carrying wheels. Now one of the objects of this invention is no longer to use the carrying wheels as driving wheels. Another object of this invention is to apply the power employed to both of two wheels placed on either side of a central rail, and to obtain the requisite holding or bite on the central rail by causing such two driving wheels to be pressed towards each other, and consequently against the rail, by means of springs and apparatus suitably arranged for causing the two driving wheels (on each side of the central rail) to press the rail more or less, according as more or less holding to the rail is required from time to time.

The driving wheels of the locomotive engine, shown in the engraving, Plate IX. are applied horizontally on each side of a centre or middle rail, and are pressed towards each other by means of springs, the pressure of which can be regulated by adjusting screws, or by any other convenient means, so that they may be pressed towards each other with any degree of force the springs will admit of. The pressure, therefore, of these wheels is exerted simultaneously on each side of the middle rail. By such an arrangement it will be evident that the bite or adhesion necessary to propel the train is independent of the weight of the engine, and as the adhesion can be increased or diminished exactly according to the amount of force with which the driving wheels are pressed against the rail, this system obviates the slipping of the driving or propelling wheels upon the rail, heretofore consequent on making the driving wheels also carrying wheels in a locomotive engine.

Fig. 1, is a side elevation, and fig. 2, a cross section of a locomotive engine and fig. 3, is a plan, with the boiler and such parts omitted as would interfere with the view of the same. *a, a,* are the driving wheels worked by cranked axes. Each wheel is worked by a pair of cylinders, the one above the other, the pistons of which operate on the axes in much the same way as the engines of the present locomotive. The slide valves may be at either side of the cylinders, and worked by eccentrics placed on the axes. To secure the necessary bite on each side of the middle rail, the lower bearings of the axes are at liberty to move for a limited distance horizontally, in mortices or slots for that purpose in the horizontal frame, *b, b*; these bearings are pressed towards each other by the springs, *c, c*. To effect the desired adjustment of the pressure of the springs, the rods are connected to the centre pieces, *e, e*, one of which has a right and the other a left-handed female screw through it, the threads of which fit the right and left-handed screws on the rod, *f, f*. On one end of *f, f*, there is a bevel wheel *g*, working into another bevel wheel *h*, the axis of which is carried up in front of the fire box, as seen dotted in fig. 3, and has a handle accessible to the engineer, so that the pressure of the springs on the driving axes, and consequently the bite of the driving wheels on the middle rail, can be adjusted at pleasure when the engine is in motion.

The claim is for the mode of giving motion to locomotive engines, whereby two actuated wheels, *a, a*, are used; and the causing of two wheels to be pressed towards each other and to a central rail.

THREE-CYLINDER LOCOMOTIVE ENGINES.

GEORGE STEPHENSON, of Tapton House, Chesterfield, in the county of Derby, engineer, and WILLIAM HOWE, of Newcastle-upon-Tyne, in the county of Northumberland, mechanic, for "*an improvement in locomotive steam-engines.*"—Granted February 11; Enrolled August 1846, 11.—(Reported in the *London Journal.*)* (*With Engravings, Plate* IX.)

The ordinary kinds of locomotive engines are, as is well known, constructed with two horizontal, or nearly horizontal, steam-cylinders, disposed parallel to each other, either between or outside the wheels of the engine; the present improvement consists in substituting for one of the said steam-cylinders two smaller steam-cylinders, with suitable valves, &c.; the smaller cylinders being of such dimensions that the contents or capacity of the two together will be equal to the contents or capacity of the larger cylinder for which they are substituted. The two small cylinders are placed one at each side of the central line or middle of the breadth of the engine, and at equal distances from that central line; and the remaining large cylinder is situated in the said central line, instead of at one side thereof as usual. The crank-pins belonging to the smaller cylinders are arranged parallel to each other, and pointing in the same direction; and the crank-pin of the central cylinder is so placed, that the direction assumed by its radial line will be at right angles to the direction assumed by the radial lines of the other two crank-pins.

The object and effect of this improvement is to counteract or neutralise any tendency that the oblique action of the several connecting-rods on their crank-pins may have to produce a lateral vibration or rocking motion of the engine upon its supporting springs, when travelling very rapidly; because the oblique direction in which each connecting-rod acts, when the piston is near the middle of its course, causes the exertion of a force either to lift up or press down the guides which retain the joint at the end of the connecting-rod and of the piston rod in its intended rectilinear motion; and in the common locomotive engines, with two steam-cylinders, this force operates alternately at opposite sides of the central line of the engine, and consequently tends to produce the lateral vibration or rocking motion above mentioned. But this tendency to produce lateral vibration will be wholly counteracted or neutralised in locomotive engines constructed according to this improvement; because the central steam-cylinder, with its connecting-rod, is operative at the middle of the breadth of the engine, and therefore the lifting or depressing force resulting from the oblique action of that connecting-rod will act equally on both sides of the engine; and further, as the pistons of the two small cylinders act simultaneously, and in the same direction, the lifting or depressing forces which may result from the oblique action of their connecting-rods are equally operative at the same time, and in the same direction, at opposite sides of the said central line, and at equal distances therefrom, and will therefore have no tendency to produce lateral rocking.

Plate IX., fig. 1, is an elevation of an improved locomotive engine; fig. 2, is an end view, partly in section, of the three steam cylinders, with their valves and accessaries, on an enlarged scale; and fig. 3, is a corresponding horizontal section and plan of the same parts. The ordinary parts of the locomotive engine being well known, any description thereof is unnecessary. *a*, is the central steam-cylinder, situated beneath the boiler. *b*, is the uppermost of the two guides for directing the motions of the joint by which the end of the central piston-rod is attached to the forked end of its connecting-rod, the other end of this rod is secured to a crank at the centre of the axis *c*, of the driving-wheels. *d, d*^{1}, are the two small steam-cylinders. *e, e*, are the guides for the joints of the piston-rods: each joint is connected by a rod *f*, with a crank-pin *g*, on the nave or boss of each driving-wheel. The requisite distribution of steam to the cylinders *a, d, d*^{1}, may be performed by means of sliding-valves, and working gear, in the usual manner, but so that the valves of the two cylinders *d, d*^{1}, will always be moved simultaneously in the same direction, which may be done by the working gear, without requiring any other eccentrics on the main shaft *c*, than is usual. In fig. 2, the valves are represented as sliding against vertical surfaces at the sides of their respective cylinders, in order that the valve-rods may point directly to the central line of the main shaft *c*; which arrangement of valves (as well as the arrangement of all the wheels *h, i, j*, beneath the cylindrical part *k*, of the boiler) forms part of certain improvements in locomotive engines, described in the specification of a patent obtained by Robert Stephenson, June 23, 1841; but although that arrangement of valves (and of the six wheels) is suitable for engines constructed according to the present improvement, the valves may be caused to slide against horizontal surfaces, and the wheels may be arranged beneath the engine in the usual manner. *l*, (figs. 2 and 3,) is the steam-chest or valve-box containing the slide-valve *m*, for the central cylinder *a*; and *n*, is the valve-rod, which passes through a stuffing-box in the end of the steam-chest. *o*, is the steam-chest containing the slide-valve *p*, for one of the small cylinders *d*; and *q*, is the valve-rod. The steam-chests *l*, and *o*, form one space for containing steam, which is conveyed from the boiler into it by the pipe *r*, and is alternately admitted into one or other of the cylinders *a*, and *d*, by their slide-valves. *s*, is the steam-chest of the cylinder *d*^{1}, which is supplied with steam from the boiler by the pipe *t*; and *u*, is the rod of the slide-valve belonging thereto. The waste steam is carried off from the cylinder *a*, by the eduction passage *v*, and from the cylinders *d, d*^{1}, by two passages *w*; these passages are continued by pipes, also marked *v*, and *w*, into the smoke-box *x*, where they are turned upwards, in order to discharge the whole of the waste steam up the chimney, as usual. The two steam-pipes *r*, and *t*, are branches of one common steam-pipe, to which they are united in the smoke-box; and the supply of steam

* An abridged account of this patent was given in the Journal for September last, without drawings.

NEW PATENTS

Plate IX

CALLOWAY'S PATENT LOCOMOTIVE

Fig. 1.

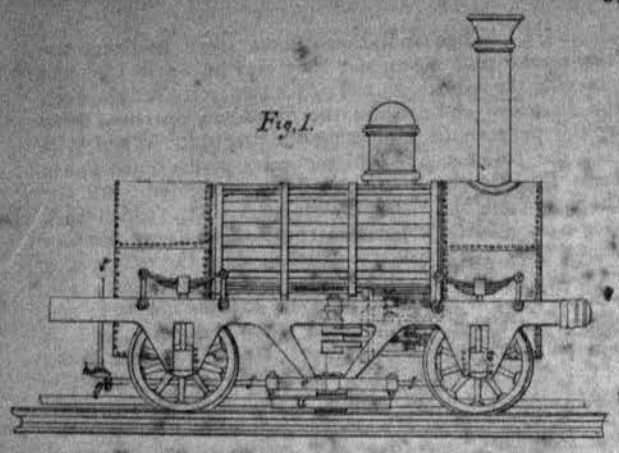


Fig. 3

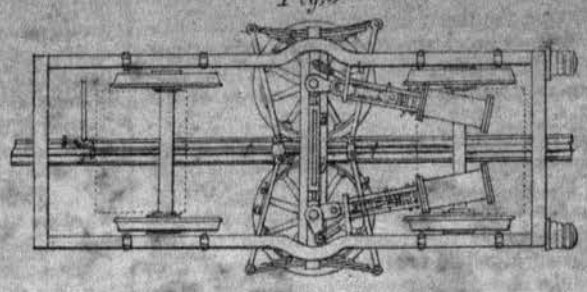


Fig. 2.

STEPHENSON & HOWE'S IMP^{D} ENGINE.

Fig. 1.

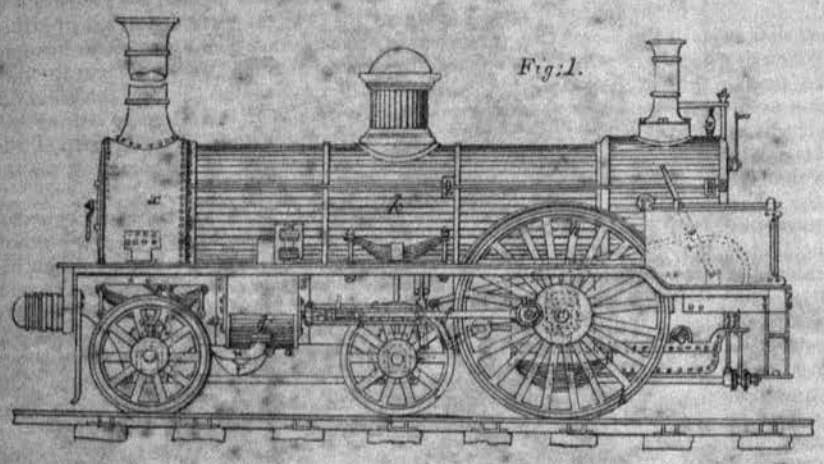


Fig. 3.

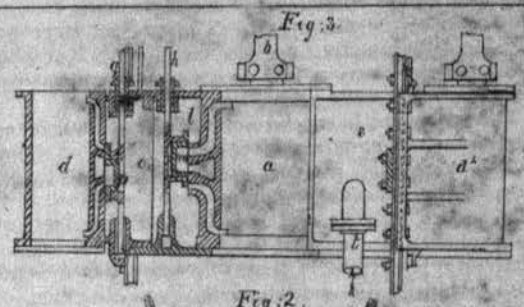
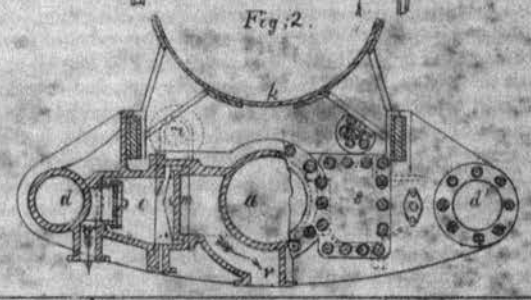


Fig. 2.



LORD'S IMP^{TS} IN FURNACES.

Fig. 1.

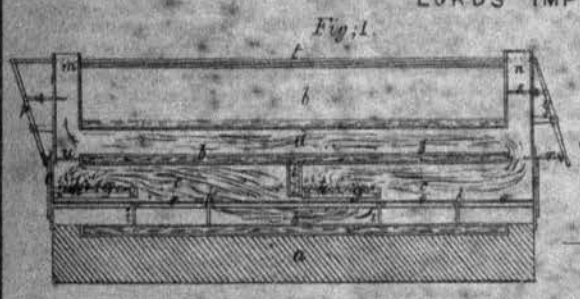


Fig. 2.

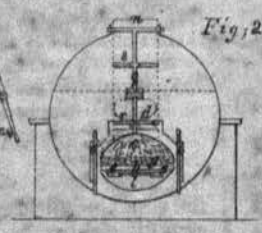


Fig. 3.

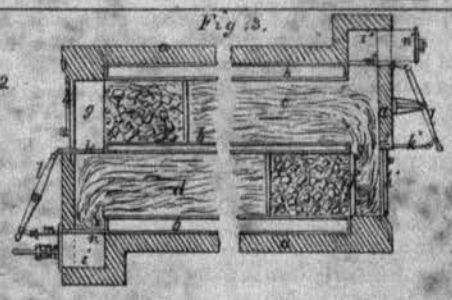
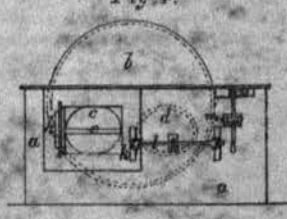
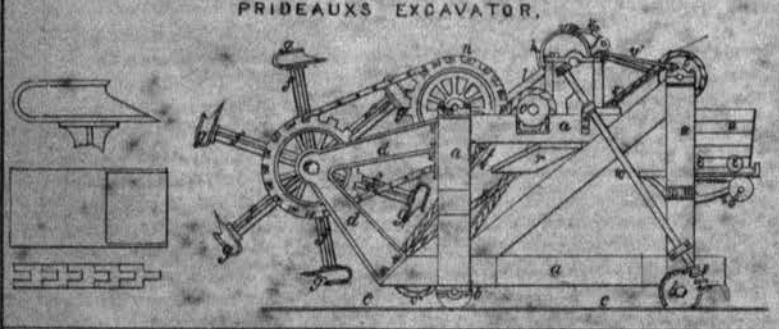


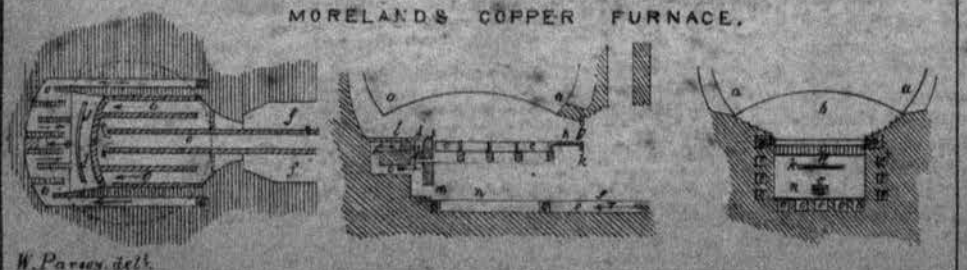
Fig. 4.



PRIDEAUX'S EXCAVATOR.



MORELAND'S COPPER FURNACE.



W. Parry. delt.

Fig. 3

CRAY'S GAS METER.

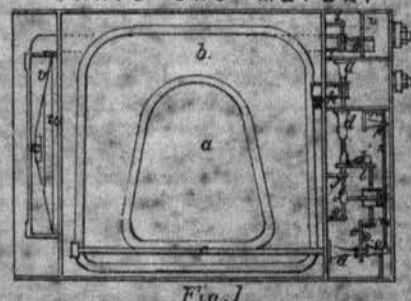


Fig. 1.

Fig. 4.

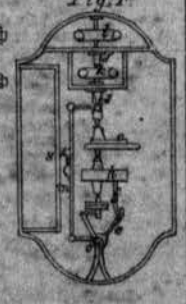
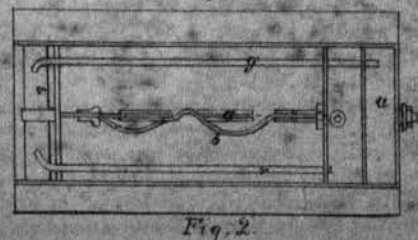


Fig. 2.



through this pipe is regulated in the ordinary manner by a valve, the handle of which is seen at the end of the boiler within reach of the engine-man.

The working gear for moving the three slide-valves is of the ordinary kind, and is actuated by four eccentrics on the main axis *c*; one pair of eccentrics being used for working the slide-valve of the central cylinder, and the other pair for working the slide-valves of the two small cylinders.

The locomotive engine shown at fig. 1, is designed to run upon narrow gauge railways, and for that purpose the two small cylinders are fixed outside the framing; but when this construction of engine is required for broad gauge railways, the small cylinder may be placed within the framing; and in this case the connecting-rods of the two small cylinders, instead of being attached to crank pins on the driving wheels, are connected to cranks formed on the axis *k*, within the framing. In place of one central steam cylinder, two small cylinders may be substituted; so that there will be four small cylinders, the piston-rods of which are connected by rods with four cranks on the main axis; the cranks of one pair of cylinders being fixed at right angles to the cranks of the other pair. The present improvement is also applicable to locomotive engines mounted on four wheels, and to locomotive engines having four or six of their wheels connected by rods in the ordinary mode of coupling.

The patentees, in conclusion, state, that their invention consists in the improvement, hereinbefore described, of applying the steam cylinders, with their pistons, piston-rods, connecting-rods, and crank-pins, in a locomotive engine, so that there shall be two steam cylinders, connecting-rods, and crank-pins, disposed at equal distances on each side of the middle of the breadth of the engine (or of the rails whereon it is to travel); those two connecting-rods acting on the said crank-pins with like motion, in the same direction, one as the other, at the same time, to urge their crank-pins onward in their respective circular orbits. And also, that there shall be one large steam cylinder, with its piston, piston-rod, connecting-rod, and crank-pin, situated at the said middle of the breadth of the engine, or of the rails, in the manner of what has been hereinbefore termed a large central steam cylinder. Or otherwise, in place of such large central cylinder, two small steam cylinders, with their pistons, piston-rods, connecting-rods, and crank-pins, disposed at equal distances on each side of the said middle of the breadth, but as near thereto as conveniently can be. In order, by such application of the three or four connecting-rods, and corresponding crank-pins, as aforesaid, to counteract or neutralise all tendency that the oblique action of the several connecting-rods, on their respective crank-pins, may have to produce a lateral vibration or rocking motion of the locomotive engine, from side to side, on its supporting springs, when travelling with rapidity.

STEAM BOILER FURNACES.

Ambrose Lord, of Allerton, Chester, toll collector, for "*Improvements in furnaces and the flues of steam-boilers, for the purposes of consuming the smoke and economising the fuel.*"—Granted June 24; Enrolled December 24, 1846. (Reported in *Newton's London Journal.*) *(With Engravings, Plate* IX.*)*

This invention consists in the application, to one boiler, of two furnaces or sets of fire-bars, which are to be fed or supplied with coal alternately; and also in arranging or constructing the flues and regulating the dampers in such a manner, that the smoke, gas, and other unconsumed combustible matters evolved from the fire which has been last fed shall pass under and through the other fire when at a clear red heat, and be thus consumed. When the fire which was last fed has attained a red heat, so as to give out no smoke, the dampers are to be reversed, which will reverse the draught. The other furnace or fire-place may then be fed or supplied with fuel, and the smoke and gas from it will pass under and through the clear red fire, and so on alternately.

In order more clearly to explain his invention, the patentee has shown two modifications, one with moveable grates, and the other with stationary grates. In plate IX., fig. 1 is a vertical longitudinal section, and fig. 2, is an end view of a cylindrical boiler, with the improvements applied thereto. *a*, *a*, *a*, is the brick-work, supporting a boiler *b*, *b*, which has two oval flues *c*, *c*, and *d*, *d*, extending through it from end to end. The lower flue *c*, *c*, is provided with rails *e*, *e*, upon which the moveable grates *f*, and *g*, run, being provided with wheels *h*, *h*, for that purpose. It will be seen that the boiler *b*, is provided with a water-space *i*, *i*, about the centre, extending across the upper half of the flue *c*, *c*, and forming a bridge to direct the course of the smoke (or a bridge formed of brick-work may be used); and the flue *c*, *c*, is provided with cross-bars *k*, *k*, from which hang swing-doors *l*, *l*. When shut, these doors serve to direct the passage of the smoke and gases, and they may be opened for the purpose of removing the ashes. *m*, and *n*, are two upright flues, each leading to the chimney; and *o*, *o*, are the fire-doors, provided with air-valves, for the purpose of regulating the draught. When it is desired to heat the boiler, both of the moveable grates *f*, and *g*, are brought towards the fire-doors, and the fires are lighted. All the dampers are then opened, by placing the levers *p*, and *q*, (which work the dampers) in a perpendicular position; but as soon as one fire (say *g*,) has attained a clear red heat, it is pushed along the rails *e*, *e*, as far backwards as the bridge *i*, *i*, and the lever *q*, is pulled outwards, whereby the damper *r*, will be opened, and the damper *s*, closed; and by means of the connecting-rod *t*, and lever *p*, the damper *u*, will be opened and the damper *v*, closed. The apparatus will then be in the position shown in the drawing, and the smoke and other combustible gases proceeding from the grate *f*, being guided by the swing-doors *l*, *l*, and the bridge *i*, *i*, will pass under the furnace and through the clear red fire on the grate *g*, and thereby be consumed and converted into pure heat; thus effecting a great economy of the fuel. When the fire in the grate *f*, has burnt clear, and the furnace requires a fresh supply of fuel, the grate *g*, is drawn forward towards the fire-doors, and fed with fuel, and the grate *f*, is pushed backwards close to the bridge *i*, *i*; the dampers are then reversed, by means of either of the levers *p*, *q*, thus altering the direction of the current or draught through the flues, and causing the smoke, &c., evolved from the coal upon the grate *g*, to pass under the furnace and through the clear fire in the grate *f*, and so on alternately. If it is desired to reduce the heat of the furnace, this may be readily done by drawing both of the grates towards the fire-doors, and opening or withdrawing all the dampers.

Fig. 3, is a horizontal section, and fig. 4, an end view of a cylindrical boiler, showing the application of the invention with two stationary grates. *a*, *a*, is the brick-work, and *b*, *b*, the boiler, which has two flues *c*, *c*, and *d*, *d*, extending through the same from end to end, on a level with each other. These flues *c*, *c*, and *d*, *d*, contain the two stationary fire-grates *e*, and *f*, one at each end of the boiler. It will be seen also that at each end of the boiler there is a flue *g*, *g**, connecting the rods of the two flues *c*, and *d*; and that the fire-doors *h*, *h**, (which must be furnished with air-valves) are fixed in the flues *g*, *g**. These flues also communicate with the vents *i*, *i**, which lead to the chimney; and these vents *i*, *i**, are connected together by a flue (which is not seen in the drawing) passing under the boiler. Now, supposing the fire-grate *e*, to have just received a fresh supply of fuel, and the fuel upon the fire-grate *f*, to be burning at a clear red heat, then the damper *k**, in the flue *g**, must be opened by means of the lever *l**, which, at the same time, will close the damper *m**, communicating with vent *i**; and the damper *n**, in the vent *i**, leading to the chimney, must be closed. At the other end of the boiler, the dampe *m*, must be opened, and the dampers *k* and *n*, closed. The smoke from the newly-fed fire *e*, will pass through the flue *c*, *c*, along the flue *g**, under and through the clear fire in the grate *f*, by which it will be consumed and converted into pure heat, which the draught of the chimney will cause to pass through the flue *d*, down the vent *i* under the boiler to the vent *i**, and thence to the chimney. When, fresh fuel is supplied to the fire *f*, the dampers must be reversed, and of course the draught; and, consequently, the passage of the smoke and heated air will be reversed also.

The patentee remarks, that although the flues, in which the fire-grates are placed, are described as being oval, and also shown in the drawing as such, yet he does not confine himself to that shape, although he would prefer its use, as allowing a greater width of fire-bars in the same circumference or area; nor does he claim the use of two fire-grates to one boiler; but he claims the application to one boiler of two separate or distinct fire-grates or furnaces (whether moveable or stationary), which are to be fed or supplied with fuel alternately, and which are to be connected together by flues, regulated by dampers in such a manner that the smoke and other products of combustion evolved from the furnace or fire-place which was last fed or supplied with fuel, shall be caused to pass under the other furnace or fire-place, and upwards through the fire of the same, for the purposes of consuming the smoke and economising the fuel.

EXCAVATING MACHINE.

Thomas Symes Prideaux, of Southampton, gentleman, for "*Improvements in machinery for excavating.*"—Granted July 15, 1846; Enrolled January 15, 1847. (*With Engravings, Plate* IX.)

The machine consists of a series of cutting instruments or buckets placed on the end of arms, made to rotate in such a way that after

they have excavated the earth, the buckets will, as they descend, discharge the contents into a series of buckets on an endless band, and then discharge them on to a trough; and again the earth is transferred from the trough on another series of endless buckets to a moveable skid or wagon. The machine appears to be complex; but, if the principle was found to answer, might, we think, be simplified.

The following description, by reference to the engravings, will explain the machine. *a*, is a wooden frame supported on flange wheels *b*, that run on iron rails *c*; on the fore part of the frame is bolted another frame of iron *d*, for carrying a shaft *e*, upon, which the revolving arms *f*, are fixed side by side of each other, and on the ends of these arms are fixed the cutting instruments *g*. For working this machine, steam or other power is applied to a crank *h*, keyed on to a driving shaft *i*, upon which is a bevelled wheel for giving motion to a corresponding bevelled wheel *k*, and connecting rod *l*, thence by another corresponding bevelled wheel to a bevelled wheel keyed on the shaft *m*, which carries a chain wheel *n*, for tranferring the motion by an endless pin chain *o*, to another chain wheel *p*, keyed on to the shaft *e*, before explained; *q*, is an endless chain of buckets revolving round the rollers *o*, *o'*, to receive the earth from the cutting instruments when in the position *g'*, and carries it on to the trough *r*, from which the earth is again removed by another series of endless buckets *s*, that pass round the rollers *t*, and *o'*, and discharge it into the hopper *u*. These endless chains are set in motion by an eccentric *v*, keyed on the driving shaft *i*, from which motion is transferred by the connecting rod *v'*, to a crank or crank-pin on the wheel *t*, fixed on the shaft that turns with the roller over which the endless buckets *s*, revolve, and thence motion is given to the lower roller *o'*, that sets in motion the first endless bucket *q*. There is one other motion on the driving shaft *i*, which causes the connecting spindle *w*, to revolve, and with it the endless screw *x*, that takes into a pinion *y*, fixed on the axle of the flanged wheels for propelling the carriage as the work advances, and which may be regulated to any desired speed. The hopper or wagon *u*, is either tilted over by turning the handle *z*, or removed on to a platform for conveying it away.

FURNACES FOR COPPERS, &c.

JOSEPH MORELAND, of Old-street, Middlesex, copper and still manufacturer, for "*Improvements in setting and fixing coppers, stills, and boilers, and in the construction of furnaces.*"—Granted June 29; Enrolled Dec. 29, 1846. (With Engraving, Plate IX.)

The improvements relate to the arranging the side and bottom air passages of the furnaces, and the application of hollow fire lumps. *a a*, shows a copper, still, or boiler. *b*, fire-place under same. *c*, furnace bars. *d*, bearing bars supporting same. *e*, ashpit. *f*, line of stokehole. *g*, furnace door and frame. *h*, apron plate or mouth plate. *i*, bridge of furnace. *j*, opening parallel with end of furnace bars at bridge, through which the heated air passes, and meets the vapour or gases arising from the burning fuel, and whereby a supply of oxygen in a rarified state being given it, or them, combustion takes place. *k*, valve or slide with handle to the same, and communicating with the front at door-frame for regulating the necessary amount of rarified air to be admitted in at the bridge of the furnace, which must be opened immediately after the fuel is thrown on the furnace, and to be closed when the combustion of the coal has taken place; holes or pins to be provided in the handle of the same, to prevent its being opened any wider than is absolutely necessary for the combustion of the fuel. *l*, flame bed or butt formed of fire-tiles or other incombustible materials, to cover the air-flue or oven, through which, by flame passing from the furnace, heat is communicated. *m*, door and frame, through which the dust and cinders may be removed, which will necessarily fall through the air opening, *j*. *n*, cast iron plates at bottom of ashpit, covering the air-flues, upon which the heat from the furnace and fire-place is reflected, and communicated through the same to air passing through flues underneath, and which plates are to be kept free from accumulating ashes. *o o o o*, air-flues for the atmospheric air first passing under and along the centre of ashpit, and dividing itself right and left under same, then passing on each side of, and in, the ashpit wall, and continuing on through the hollow fire lumps which line the furnace; after which, continuing on right and left under flame bed or butt, where it then meets and descends to the valve or slide at *k*, and passing through which, it then enters the furnace in a heated and rarified state at the opening at bridge of same, *i*. *p p*, hollow fire lumps for the lining of furnace, through which the air is continued from the flues of ashpit. *r*, entrance for the admission of the atmospheric air to flues, which is to be assisted and increased by the use of a fan or blower attached to same.

The darts or arrows show the direction which the atmospheric air takes in its progress to the opening at bridge of furnace at *i*. Also, the faint lines on ground plan show the construction of air-flues under the line of stokehole and ashpit. Also, the letters *f* to *b*, and *b* to *f*, shown in the cross section, mean respectively front to back, and back to front. And also, the dark dotted circle shown on the ground plan, is the bottom of copper, still, or boiler.

IRON AND BRASS MOULDS.

DAVID YOOLOW STEWART, of Montrose, Scotland, iron-founder, for "*Improvements in moulding iron and brass.*"—Granted July 14, 1846; Enrolled Jan. 14, 1846. (With Engraving, Plate IX.)

Fig. 1 is an elevation of the machinery and apparatus, and fig. 2 a vertical section of some of the parts; *a*, cylindrical mould box, preferred to be made in two parts and connected together, as shown by bolts passing through the straps *b*, and keyed up by wedges. At the lower end is a step to receive the lower end of the pattern *c*, which is preferred to be of metal. *d* a presser, to press the sand into the mould-box *a*, around the pattern *c*. The presser consists of a tube of thin sheet metal, with a projecting flange *d'*, or portion of a screw; the worm or flange not passing completely round, but it leaves an interval between the two ends. *f* is a projection, there being a similar one on the other side. These projections loosen the sand above *d'*. The tube *d* revolves round the pattern *c*, and keeps it upright; and as the presser *d* revolves, it rises by the inclined surface *d'*, that surface continually feeding in the sand, and pressing it down upon that immediately below it, thus causing the sand to be compactly pressed into a mould. On the upper end of the tube *d*, is fixed a cog-wheel *e*; and the upper end of the tube *d* revolves in an opening formed in the cross-head *g*, such cross-head being guided in its upward movement by the guide-bar *h*, and the revolving square-bar or axis *i*, which turns in bearings at *j j*. On the upper end of the axis *i*, is fixed a bevelled toothed wheel *k*, which receives motion from the axis *l*, by means of a bevelled toothed wheel fixed thereon; and such axis *l*, receives motion from a steam engine or other power, by a strap acting on a fixed drum *m*, as is well understood, or by other convenient means. *n* is a pinion which slides on the revolving-bar or axis *i*, but turns therewith.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

SOCIETY OF ARTS, LONDON.

On the evenings of the 3rd and 10th ult., this Society, for the first time, attempted to establish an Exhibition of British Manufactures: although it was not very extensive, it contained several interesting objects of art. The specimens of Carving by Machinery attracted attention. Those by Irving's patent were distinguished for clearness and precision of form; especially in mouldings, for which, indeed, this process seems best adapted. There were also some productions by means of heated moulds, which, though good, were eclipsed by those from Jordan's patent, which were very fine. A Bunch of Hops and Brace of Partridges were worthy to hang by the side of Grinling Gibbons's works. A portion of the Ghiberti Florentine Gates was also very successful. The machinery employed accomplishes precisely the task assigned to the sculptor's assistant. It clears away all the superfluities and prepares the object for the final touches of the artist,—no matter how high the relief, or how low and intricate the undercutting. Another feature connected with it, is that simultaneously several copies can be executed. The impetus which this machinery is calculated to give to internal decoration cannot be too highly estimated. It multiplies artistic power without limit; only stopping short of that perfection which makes the artist's last touch and approval necessary. This machinery is applicable alike to marble, alabaster, and wood.

The exhibition of Glass was not extensive. The specimens by Messrs Richardson, of Stourbridge, proved that we are already chemists enough to paint what colours we please on glass, as on china. This is quite a novelty. Some of the forms of the vases are very elegant—chiefly based on ancient examples.

The specimens of Metals were few and not very satisfactory. The Coalbrookdale Ironworks, though they have executed some pretty good castings, sent nothing to this Exhibition. Mr. Smith's specimen of chasing on sheet silver was interesting: it supersedes casting, and economises two-thirds of the precious metal. There was only one specimen of electro-gilding.

The show of Pottery and Porcelain illustrated that branch of English manufactures, and enabled any one so disposed to become acquainted with its rise and progress. The specimens were classed chronologically,—begin-

ning with the butter-pots and many-handled "tygs," or drinking cups, of the time of Queen Elizabeth, and ending with the pottery of the present period, showing how the manufacture of English pottery has advanced step by step, until it has reached that perfection by which it commands a preference throughout the world. The manufacture at Delph is almost put down by it, and the best porcelain now to be met with at Dresden and Paris is of English manufacture, notwithstanding duties almost prohibitory. So far as successful *imitation* is concerned, English pottery has accomplished all that can be desired. It has superseded, owing to its superior make and cheapness, the originals which it imitated. The old native Delph plate is not to be compared with the modern English specimen. Wedgwood in many points surpassed the Etruscan vases; while the best specimens of Sevres vases and Dresden figures are equalled by us in general execution, and in many features of workmanship,—though inferior in some kinds of colour and in the "glazing." In respect of price, English manufacture has in all cases enormous advantages.

There were some noble specimens of Statuary Porcelain exhibited by Messrs. Copeland and Garrett, and in "Parian" by Messrs. Minton. From these specimens it appears that the works of the sculptor may be placed within the reach of unlimited numbers. The material or "body," in both cases, is very beautiful, and has only to be connected with good Art to produce a perfectly successful union. The workman, it is true, must have an adequate knowledge of the human form in order to be able to unite, with proper feeling, the separate parts in which the figure is necessarily cast. There were also some beautiful Porcelain Mosaics of Messrs. Minton.

Some examples of Block Printing for paper-hanging, exhibited by Mr. Horne, of Gracechurch-street, were good; one was a copy, on a large scale, of Murillo's "Beggar Boys," in the Dulwich Gallery.

We hope next year to see a large number of articles in cast iron, brass, and bronze, adapted for ornamenting the interior of edifices; likewise some specimens of carpets and paper-hangings. Some patterns which we have lately seen, manufactured in this country, are quite equal to the French.

ROYAL SCOTTISH SOCIETY OF ARTS.

Feb. 22.—George Wilson, M.D., F.R.S.E., V.P., in the Chair.

The following communications were made:—

Dr. Wilson experimented on the "*Noise of the Electric Spark in different Gases, as a means of illustrating the power of Elastic Fluids to conduct Sound.*"—The two aerial fluids experimented on by Dr. Wilson were common atmospheric air and hydrogen gas. When the electric spark was passed from one conductor in the interior of a glass globe, filled with hydrogen, the noise of the spark was exceedingly feeble, being nearly drowned by the noise of the spark taken outside from the prime conductor. On the contrary, when the globe was emptied of hydrogen and filled with common air, the noise of the spark in the interior of the vessel was louder than the exterior spark, having a metallic ringing sound.—He, therefore, suggested this as a simple method of illustrating the power of elastic fluids to conduct sound. Thanks voted and given from the chair.

By permission, Mr. Pownall exhibited Nott's "*Patent Electro-Magnetic Telegraph.*" The telegraph was shown in action, and was described by William Alexander, Esq., F.R.S.E., F.R.S.S.A. The Electro-Magnetic Telegraph invented by Messrs. Nott has a hand, similar in appearance to the hands of common clocks which tell the hour; this hand is longer on one side of the pivot or axle on which it moves than on the other side. The longer end points to a circle of four alphabets which surrounds the dial-plate, and the shorter end to a circle of figures which is at a short distance from the centre of the dial-plate. The hand (or hands) moves with what is termed a dead-beat escapement, the motive power being the electric fluid acting upon a toothed wheel with pallets and stops, by which the utmost regularity of movement is obtained. When the hand is to be put in motion, a key, something similar to a key of a pianoforte, is pressed, and the pressure removed when the hand points to the letter necessary to spell a word, or to a figure necessary to express a signal, as the case may require. Thus words are spelled with unerring accuracy, and signals pointed to without the possibility of mistake. No magnetic needles move on the dial-plate and by their deflections indicate the letters, or words, or signs, necessary, in the magnetic telegraph hitherto in use, to form a sentence. There is no alarum used, but a bell is used, the number of strokes struck on which indicates certain things to be communicated from one station or terminus to another. There is but one wire employed, and the cost of the apparatus, batteries, &c., is not much more than half the cost of the mode now in use. The great advantages of this invention are stated to be its simplicity, its accuracy, the ease with which it is worked and understood, and the almost impossibility of its sustaining injury, unless from great violence; there is no intricate mechanism, no springs or weights, and only one wheel. It was stated that it had been adopted between Northampton and Blisworth, where it answers admirably; and that it had been favourably reported upon by Mr. Faraday and Major Brandreth to the Admiralty; by Mr. Brande and by Professor Backhauffner;—that this latter gentleman has introduced it in a course of lectures, at the Polytechnic Institution. It was stated to be a most important improvement on the rapidity and accuracy of telegraphic correspondence, and a novelty in the application of the principle of electric communication.

March 8.—David Maclagan, M.D., F.R.S.E., President, in the chair.

Experiments were exhibited, showing the perfect safety of the patient from Explosion during the administration of the *Vapour of Sulphuric Ether;* and a description given of the forms of the Inhaler. By Mr. Archibald Young.

Mr. Young concluded his series of experiments on the inhalation of etherial vapour by showing that the etherised contents of the lungs would not explode; from which he conceived he had demonstrated the perfect safety of the patient from burning or explosion. A discussion followed, in which Dr. Wilson, Mr. Glover, Mr. Hunter, Dr. Douglas Maclagan, and Dr. Roberts, took part; in which, although it was admitted that there was little or no risk to the patient from internal explosion or burning, yet that, as a volume of vapour of ether, when mixed with 35 volumes of common air, formed an explosive mixture, persons using ether should not do so rashly, as, in certain circumstances, instances of which were given, explosion had taken place in the apartment; not, however, fatal ones, nor did they occur during the administration of ether by inhalation.—Mr. Young showed various simple forms of the inhaler, some with valves and some without them, and very portable, made of japanned tinplate, as suggested by Professor Simpson.

Description of an *Improved Kinnaird-Grate*, combining more perfect Radiation of Heat, with a provision for the admission of Air and returning it Warmed into the apartment. By Mr. James Gray.

This grate, whose heating power was stated to be much superior to the common form of the Kinnaird-Grate, is in appearance the very reverse of the common kind. In place of retreating backwards, it protrudes into the apartment as it were, by which means the fire is brought more forward with less risk of danger by the overheating of the back brick. It also radiates heat more perfectly into the apartment; and a provision is also made for cold air to pass up along the heated brickwork of the building, and along the top of the covering of the grate, which issues therefrom by pierced apertures pleasantly warmed into the room. Mr. Gray stated that this grate had given much satisfaction to those who had tried it. In appearance it is as elegant, if not more so, as the common Kinnaird-Grate, and not more expensive.—Referred to a committee.

ROYAL INSTITUTE OF BRITISH ARCHITECTS.

Jan. 25.—S. Angell, Esq., V.P., in the Chair.*

A communication from W. Bromet, Esq., respecting one of "*the Arches of Upton Church, in Buckinghamshire,*" was read; and a sketch by that gentleman exhibited, showing its principal feature, viz. a carved wooden archivolt, the mouldings of which are the dog-tooth alternating with small rounds,—the outer moulding adorned with a series of diagonally-set trifid leaves of a more antique character than Gothic ornaments commonly are.

"*A description of the Remains of the Ancient Norman Refectory in the Bishop's Palace at Hereford,*" by J. Clayton.—There are few existing examples of Norman architecture which present the timber-work in such excellent preservation as that at Hereford. This great Hall is one of the earliest examples of the class of buildings to which belong the Halls of Westminster and Winchester. It was originally divided into one centre and two side compartments, by two ranges of columns of four each, from which sprang the arches supporting the roof; and the peculiarity of this example consists in these pillars and arches being entirely constructed of timbers. The original dimensions of the Hall were 110 feet by 55 feet: and one half of the roof now serves to shelter the principal apartments of the present episcopal residence, erected upwards of a century ago. Above these apartments, which are of one story only, are seen the upper portions of the pillars, the arches, and the roof; the lower parts of the columns being concealed in the division walls of the modern rooms. The principal arches, viz. those over the centre compartment, were of 22 feet span; and each formed of two pieces only, cut in the arched form from the solid timber—which must necessarily have been of vast dimensions. This oak, although whitened by age, is perfectly sound. Drawing of the details were exhibited; as also one conveying the writer's idea of a restoration of the interior of the Hall—showing that the original building must have had an imposing appearance, not produced by a multiplicity of parts or richness of design, but from a massive grandeur, the peculiar characteristic of this early style of architecture. A few particulars were given of the city of Hereford prior to the erection of the refectory in question, which was probably soon after the Conquest.—The Hall at Oakham was then described by Mr. Clayton as a most beautiful specimen of the Norman buildings of this class. It does not possess the peculiarity of being composed entirely of timber, nor has it the magnitude of the examples at Hereford; but remains in an excellent state of preservation. It formed part of the ancient castle; and is now used as the county courts for the shire of Rutland.

"*Observations on the Ancient Roof of the Church at Adel, in the West Riding of York,*" by R. D. Chantrell, Esq.—Among the peculiarities particularly alluded to was the corbel table, which had evidently been adzed out of the solid timber, having projecting pieces which fitted in between the ceiling joists, or rather beams. Mr. Chantrell was of opinion

* This evening's proceedings were accidentally omitted in last month's Journal.

that this roof was originally open, like the cradle roofs of the 13th century, many of which occur in the churches of Yorkshire. The south door was mentioned as exhibiting one of the finest specimens of Norman sculpture in the country. The capitals of the principal pillars of the chancel arches are in the best preservation. That on the north has a group of figures representing the Baptism, and the other the Crucifixion. It was mentioned that the same character and grouping occur above the door of the Baptistry of the Church of St. Basil at Bruges, known as "La Chapelle du Saint Sang," which edifice was certainly founded in 1082. The kite-shaped shield used in the time of William the First, and other peculiarities of style which occur in the sculptured figures of one of the southern capitals, are additional reasons for assigning the date of the 11th century to this building.

March 8.—S. ANGELL, V.P. in the Chair.

Mr. J. SCOTT RUSSELL read the concluding portion of a paper "*On the Interior Forms of Buildings with respect to the Laws of Sound.*" After recapitulating his first and second principles, he went on to examine the *third* cause of bad qualities in the construction of a room. He showed that in a large square room, of the usual form, the reflexion of the same sound was carried to the speaker's ear by different paths, and in different periods of time; the result of which was the confusion of successive sounds and syllables with each other—and so a prolific cause of indistinct hearing. It required another principle to afford the remedy of these evils, and that was the fourth principle—which he believed was quite new. He might venture to call it the principle of the *non-reflexion* and lateral accumulation of the sound wave. It had originally been suggested to him by the observation of a similar phenomenon in the wave of the first order in water. This wave he considered to be the type of the *sound wave;* and on examination he had found experimental evidence of the same phenomenon in the latter wave. He had observed that at angles below 45° the sound wave was no longer completely reflected from the surface on which it impinged; and that when the obliquity of the wave to the surface was 60°, a phenomenon followed of total *non-reflexion*—and the wave continued merely to roll along the surface in a direction parallel to it. This fact furnished a ready means to remedy the evils so often produced by the reflexions and echo and interference of sound in public buildings.—Wherever it was possible to place flat or curved surfaces at such angles that the direction of the sound should be very oblique to the surface, it might be harmlessly disposed of, and prevented from injurious reflexion.—This was exactly what the stalls of a choir, the side chapels of a cathedral, and the partitions of boxes in an opera house, did so successfully for buildings of a large class. The same principle enabled him to explain the Whispering Gallery of St. Paul's (which is circular) and another equally celebrated, mentioned by Saunders, which is perfectly straight. The same principle also explained the conveyance of sound along the smooth surface of a lake and over the flat surface of a sandy desert:—as well as the extraordinary reverberation or accumulation of sound in some portions of a building, The *fifth* principle was that of the polarity of the human voice. Mr. Russell showed the rapid diminution of intensity of sound on both sides of the axis of the mouth;—and that instead of extending in a circular wave round the head of the speaker, as had been supposed, the line of hearing-distance was an elongated oval extending forwards from the mouth.

March 22.—Mr. C. FOWLER in the Chair.

Mr. JAMES BELL read his essay "*On the Adaptation and Modification of the Orders of the Greeks by the Romans and Moderns,*" for which a Medal of Merit had been awarded:—

The order, in Grecian architecture, constituted the chief feature, and contributed its character and proportions to the entire edifice. The column, on the introduction of the arch by the Romans, lost its importance, and together with that, its extreme delicacy of finish and proportion; in place of which, luxuriance and richness were substituted, so as to harmonise more thoroughly with the sentiments of the Roman people. This change gradually led to a complete debasement of the style; the arch, after the Constantine era, gaining in importance more and more until the Pointed style arose from the ruins of the Classic. On the revival, the Italians by the study of the antique, endeavoured to restore it to its primitive purity, and many of them were eminently successful in the attainment of their object, although the painter-architects introduced many flagrant abuses both in composition and detail. In the north of Europe, where the Pointed style had obtained a firmer footing, the change was produced by the grafting of Classic details on a Gothic outline, constituting the Elizabethan and Renaissance; and, at the same time, an increased intercourse with Italy led to the adoption of the new style in all its purity, for much of which we are indebted to Sir Christopher Wren, in whose school it was thoroughly naturalised. Since the middle of last century, the study of Grecian remains has led to the further purification of the Roman, together with a due appreciation of some of those delicacies of form and proportion which were previously either misunderstood or altogether overlooked, although the feeling of the age, so far as regards detail, tends rather to imitation than to modification. To the Germans, however, was due the merit of the most complete appreciation of the works of the Greeks,—a result which might have been anticipated from the analogy between the habits of thought and feeling, and even language, which may be traced between the two nations.

INSTITUTION OF CIVIL ENGINEERS.

Feb. 28.—Sir J. RENNIE, President, in the Chair.

A supplement to the papers on "*the Helder or Great North Holland Canal,*" by Mr. G. B. W. JACKSON, was read. It contained a description of the harbour and works at Nieuwediep, which might be considered as legitimately connected with the Helder canal, inasmuch as they were constructed with a view of affording shelter to vessels of war and merchantmen navigating the North Sea. The banks or shoals situated at the mouth of the Marsdiep channel act in a peculiar manner; they narrow the entrance, resist the undue influx of the tides, thus preventing injury to the coast of the Zuyderzee; they oppose difficulties to the entrance of hostile fleets, as the navigable channels run within range of the protecting forts; and they assist in maintaining the velocity of the currents which keep the channels at their usual depth. On the coast of Holland the ebb-tide continues to pass off along the Noorder-gat a full hour and a half after the tide has commenced flowing up along the Schulpen-gat; this can only be accounted for by supposing that the tide runs up from the south-west, and enters the Schulpen-gat, whilst the ebb still continues, in consequence of the draft of the tide northward along the coast. The Schulpen-gat and Landsdiep may therefore be termed the flood-channels; whilst the Noorder-gat may be considered the ebb-channel. Upon these spots, whose preservation was of such consequence to the country, the Dutch have lavished their best care, and exercised their ingenuity.

The shore-works consisted chiefly of groynes, composed of timber piles and fascines, with stone covering. The average length was two hundred yards, with slopes of about one in eight or ten. In consequence of the report of the commission appointed in 1780, the engineers, Brunnings and Goudrai, were instructed to proceed with the formation of a warping bank of fascines, 7360 feet long, with double planking guard to accumulate the sand, in order to fill up the interstices of the fascines, and thus preserve them from decay. A breakwater also, 1850 feet in length, 73 feet wide, at 3 feet below high water, with slopes of one to one. This was also formed of fascine beds, weighted with 2000 lb. of stone, and 4000 lb. of tiles upon every superficial area of 144 square feet. The upper surface was covered with matting, and made convex, the centre being one foot and the sides three feet below the level of high water. Hurdling was then used, and the whole was covered with blocks of stone weighing from 1500 lb. to 1800 lb. each. An additional length of 2080 feet was subsequently built, the warping bank being completed, and by means of these works the ebb-stream was increased to such an extent as at once to deepen the channel eighteen inches, although the bed was of clay. In 1783, dredging was resorted to, and, with the action of the stream, a depth of nineteen feet was arrived at. The whole length of the proposed harbour was then dredged to a depth of seventeen feet under high water level. Another warping bank of 3675 feet in length was then constructed, with numerous groynes to arrest the sand and preserve the coast. A quay-wall and jetty were then added; the piles composing the latter were covered with sheet-lead between high water level and one foot below the ground, in order to preserve them from the ravages of the *Teredo Navalis*, which, however, it is the popular opinion, may be also prevented by driving the piles through fascines. A portion, sixty feet in length, of the breakwater was torn away by a storm: this slip was filled up with large stones, but they were ineffectual, and fascines were ultimately had recourse to for repairing the breach. The depth of the channel was thus increased to nearly thirty-five feet, so that frigates could pass with safety. In 1789, one hundred and fifty-one vessels were lying there at anchor, fourteen of which were men-of-war, and four were East Indiamen. The basin is 1292 feet long, and 646 feet wide, with large storehouses, dock buildings, fortifications, &c., of the most solid description, and thoroughly complete for a naval arsenal. The details of every part of the works were given. A special vote of thanks was passed to Mr. Jackson for the paper.

Remarks.—An interesting discussion ensued, in which the highest compliments were paid to the author for the paper he had presented, and the manner in which it was illustrated. A description was given of Dymchurch wall which defends Romney Marsh, an extent of 24,000 acres, and also of several other sea-defences at the mouth of the Thames, and elsewhere, in which fascines were extensively used. The Nene embankments were also described. Specimens were shown of the *Arundo Arenaria*, a coarse grass, whose roots extend sometimes to a length of upwards of thirty feet, and which is eminently useful in securing the sand of the coast from being blown or washed away.

Among several cases of the failure of protecting-walls, one was particularly described of a nearly vertical sea-wall, whose foundations were sunk down full five feet below the shingle of the coast: the wall was built with great care, and with first-rate materials—it was, however, exposed to the action of a heavy sea in North Wales. During a severe storm, the waves were thrown up in a mass full forty feet above the wall, and falling from that height with the force due to such a distance and mass, very speedily destroyed the whole wall. In quite as exposed a situation, a slope, which enabled the waves to expend their strength, and broke them up into foam, did not suffer at all. Numerous deductions were drawn from these and many other instances, all unfavourable to the theory of vertical sea-walls, which it has recently become fashionable to recommend as a theoretically even more correct form, in opposition to the well tried plan of eminent civil engineers, who have almost universally adopted slopes for resisting the action of the sea.

March 2.—This evening the discussion upon Mr. Jackson's paper was renewed, and was extended to such a length as to preclude the reading of any paper.

The comparative advantages and disadvantages of vertical and sloping sea-walls were discussed, and instances were given of the effect of seas upon the former when walls of a certain batter or curved face surmounted by an overhanging coping of such extent as to deflect the curling wave outwards, and throw it back upon itself rather than allow it to fall bodily inwards, as in the case of the Penmaenmawr wall mentioned at the last meeting. The manner in which the waves were driven up long slopes, acquiring force as they travelled along, was contrasted with this. On the other hand, the action of the various kinds of waves was shown upon sections of the beach at Madras, where the surf was so notoriously bad, and where it appeared that by the clawing off of the waves the beach was washed away into natural steps, of a level and then a small slope of 45°. A breakwater had been formed off that beach by throwing in loose masses of rock forming their own slope; this, when carried up to within ten feet of the water-level, stood well.

In Knootka Sound the same effect of the drawback of the waves was noticed. Sections of the Mole of Venice were shown. That mole, which is nearly 16 miles in extent, had a section of a sloped foreshore with a nearly vertical wall, then a slope at another angle, and above high-water mark another nearly vertical wall. When the seas rolled in upon the mole they partially curled over against the first wall, and were projected with augmented force against the upper one. The consequence was, that the mole was partially destroyed, and in the repairs, which had been executing for some time, it had been reduced to one uniform sloped face, at an angle of about 15°. The destruction of the nearly vertical walls of Portpatrick was also noticed. Those walls, although constructed of the finest Anglesea limestone, well dressed, dove tailed, and tied down vertically and horizontally by iron chain-bonds, were completely overthrown; and, until the thickness of the wall was increased to 80 feet of solid material, it could not be made to stand. The situation was extremely exposed, and the sea frequently sprung 50 feet above the top of the light-house, which was itself 60 feet above the level of high water of spring tides. The causes of the peculiar action of the draw-back of the waves, as exemplified by the removed shingle from the beach when the wind was on shore, and its accumulation when the wind blew off the shore, were also discussed; and it appeared to be the received opinion that, in these cases, the upper part of the waves being acted upon by the wind, a pecular rolling motion in a counter direction was imparted to the lower wave, which acted upon the shingle in the manner alluded to. This action appeared, however, only to extend to a depth of about nine feet, which it seemed to be agreed was the ultimate depth of detrimental action of all waves. The forts of Boulogne were given as further examples of the reflection of waves from nearly vertical walls; but it was shown that the darting over of the waves there was caused by their falling within the re-entrant angles of the fortification.

The effect of advanced groynes in protecting sea-walls was exemplified by the concrete walls at Brighton and Dover, which were extended merely for retaining walls; and such was the effect of the groynes, that since they had been put down the shingle had accumulated to such an extent that the sea did not approach injuriously to within 100 feet of the base. Our limits will not permit a greater detail of this interesting discussion, which will, however, appear entire in the proceedings of the Institution.

March 9.—The paper read was "*On the practical forms of engineering works exposed to the action of the waves of the sea, and on the advantages and disadvantages of certain forms of construction for breakwaters and sea walls.*" By Mr. JOHN SCOTT RUSSELL.

Although agreeing as a general proposition, with the truth of the observation, that it was impossible to lay down any one undeviating rule for a form of sea wall which should suit all cases,—the author had, from long and careful experiment, and examination of various localities, endeavoured to classify certain forms of artificial constructions, and to adapt them to certain cases, having reference in each case to the action of the waves to which they were to be exposed. His first process was to examine the action and character of the several kinds of waves, deducing as a given axiom, that,—First, the common form of waves is cycloidal. Second, the motion of the waves in a disturbed state is circular, and in a vertical plane. Third, the water near the top of a wave moves the same way as the wave itself. Fourth, the water in the hollow between the waves is receding. Fifth, the power of a wave is exactly in proportion to the height of its crest above the hollow between the waves. Sixth, the greatest power a wave can exert is at the moment of the crest breaking over into the hollow. Seventh, waves in the British seas have rarely been seen of a greater height than 27 feet above the hollow, and 32 feet may be taken as their greatest unbroken height; those of the Atlantic being stated to range higher. Eighth, waves have never been seen of the full depth of the water forming them, hence it is deduced that the greatest force waves can be exposed to may be determined by the depth of the water they are placed in. Ninth, there two or more classes of waves,—wind-waves, short, high, and superficial; and storm-waves, which are long, low, and deep. Tenth, the depth of agitation caused by a wave is in the ratio of its height and length conjointly. Reasoning upon these data, the paper then proceeds to examine two classes of hydraulic works. First, those which are designed to act upon the waves; and, second, those whose structures are exposed to the sea without any design of controlling it, but only to guide it under particular circumstances.

Of the first class are sea walls, piers, and other sea defences intended to restrain the action of the waves; for the forms of which a number of designs were given, ranging between the flat slope, with a foreshore, and the vertical wall. Of all these the preference was given to a wall having a concave or cycloidal curved face, to carry the wave up without breaking; overhanging coping curved on the underside to return the wave upon itself, and a recessed parapet on the outside to prevent the wave from being thrown inside. For breakwaters, whose object it was to resist the waves and produce still water within side, the best mode, under all circumstances of locality, variety of materials, and cost appeared to be the depositing of the large and small materials, and allowing them to find their natural slope under the action of the waves.

Of the second class, are works designed to direct the scour at low water, but which are quite covered at high water; the foundations of lighthouses, &c.—the object being to oppose the least possible resistance to the waves, and to suffer the least from them. Groynes, embankments, and other works intended to be under high water, also coming under this class; the best form is the parabola with the foot curved outwards on each side—the apex being raised or lowered, and the base proportioned to its application. This form being extended upward approximates to that of the Eddystone, Bell-rock, and Skerry-vore lighthouses, which have withstood the action of heavy seas so successfully.

The vertical wall was condemned for many satisfactory reasons; the cost of workmanship, the expensive character of the materials, the liability to destruction, if a breach be made, and the unsatisfactory action in consequence of the waves making a clear breach over them in heavy weather.

In the discussion that ensued, many interesting illustrations were given of the truth of these positions, derived from the works of Whitehaven, those on the South Devon Coast, and those at Hartlepool, in which latter case the strong red marl, dry punned, mingled with small stone, and faced with pitching, had been satisfactorily employed at a very small cost for the construction of piers.

March 16.—The paper read was "*A description of the method adopted in Preparing the Foundation, and in Building the Bridge over the Poldervaart, on the line of the Amsterdam and Rotterdam Railway.*" By the CHEVALIER CONRAD, M. Inst. C.E., compiled by Mr. C. MANBY (secretary), from documents furnished by MYNHEER WENCKEBACK.

This bridge derived its importance from the peculiarly treacherous nature of the ground upon which it was constructed, for, although in Holland bad foundations are the rule rather than the exception, the difficulties were in this case so peculiarly great, as to demand particular notice. The Poldervaart, is a canal encompassing and conveying away the waters from the Polders, or spots of drained land in the commune of Kethel. The railway, traversing it at a considerable angle, rendered a skew bridge, of three openings, necessary—the centre one 13 feet space for the navigation, and the two side arches 21 feet space each, for the drainage water. The proceedings were commenced in the usual manner, with the intention of having separate foundations for each pier; this was by shooting in large quantities of sand, to form dams, within which, when pumped dry, the foundations would have been excavated. After a length of about 70 feet of sand, a dam 10 feet deep had been filled in, without exhibiting any signs of sinking; a heavy thunder-storm occurred, during which the whole mass of sand dam was suddenly engulphed to a depth of 29 feet; whilst there arose simultaneously, at a short distance down the canal, to above the water level, a mass of bog-earth, of an area of 4489 square feet—this mass increased at subsequent periods of the proceedings to the area of 9628 square feet. It was evident, that an extensive subterraneous shifting of the bog-earth had occurred, and there was reason to fear for the safety of the adjacent dykes and other works. Piling and fascine works were tried without success—piles of 70 feet in length, when driven and tied together by waling pieces, swerved bodily from their position, and became useless; fascines equally failed in producing stability. The engineer, therefore, determined, after directing the canal water into a side cut, to surround the site of the intended foundation with mounds of sand, allowing for their subsidence into the gulph below, and then squeezing up the bog-earth around and within the spot. This was at length completed, and the foundation pit was enabled to be pumped dry. It then became necessary to remove all the bog-earth from within the space for the foundation, which was accomplished by digging out spaces of a yard square, and filling them in with sand as they proceeded, until, by commencing at the exterior, and working inwards to the centre, all the bog-earth was removed, and a bed of sand had been formed in its place. The piles for the ordinary foundation, used in Holland, were then driven through the made ground, and the structure was completed with perfect success—the sand dams, and the masses of upraised bog-earth outside, being subsequently dredged up in the ordinary manner, to restore the canal to its original bed. In this description, the circumstance most deserving attention, appeared to be the sudden rising of the bog-earth during a thunder-storm. This is, however, of frequent occurrence in Holland; and it would appear as if the adhesion of the masses of bog-earth to the bottom was so slight, that the vibration communicated to the water by the thunder, sufficed to destroy the equilibrium, and the bog-turf, which, from its slight specific gravity, will float even when wet, instantly rose to the surface. When, therefore, as in this case, a heavy mass of sand was placed in the vicinity of such bog-earth,

the bottom was unable to resist the pressure, and the least vibration caused it to break through the crust, being engulphed amidst the lighter material, which it forced up in the direction of the least resistance. The paper treated at some length on all the precautions necessary in this and similar constructions in Holland, where such bad foundations are of very constant occurrence. In the discussion which ensued descriptions were given of the simpler methods employed in similar situations in England, where bridges of greater weight and space were constructed upon foundations of nearly as treacherous natures—for instance, on one of the branches of the Norfolk Railway, for a bridge of which the swinging portion weighed 100 tons, a series of 16 piles, driven 50 feet deep into the silt in 12 feet water, supported a cast-iron kirb, upon which a cast-iron close-jointed cylinder was lowered and secured—within this, the centre foundation was built and had stood perfectly. Other instances of raft, or floating foundations, common in Lincolnshire, were adduced, showing the simple means by which such local difficulties were overcome in England.

NOTES ON FOREIGN WORKS.

The Russian Pompeii.—The emperor of Russia has ordered that the efossioos, which have been made for several years past, near the town of Zarewim, in the county of Zaratow, should be continued, on a large scale. This town had been the capital of Tartar Chans of the golden tribe, during their 200 years domination in Russia. Some ruins of houses have been already discovered, in which divers utensils and 4000 Tartar coins have been found.

Great Adorning of the Banks of the Rhine.—Several of the old castles, casting their shadows on the waters of the Rhine, are about to be reconstructed, which will spread an uncommon lustre over these fertile and beautiful lands. Thus, Prince Frederick of the Netherlands has purchased Castle Fürstenberg, between Niederheimbach and Baberach, and will have it completely restored. The castle in its present state dates from the eleventh century, but a Roman post-tower previously existed on this far-sighted elevation. Prince Albrecht, of Prussia, has purchased Castle Schönberg, near Oberwesel; and the Prince of Prussia, Rheinfels, near St. Goar; all of which are to be rebuilt in an antique and most splendid style. [We wish something similar were done with some of our English and Scotch castles.]

Moving mountain in Italy.—From the embouchure of the Tronto up to Fermo (near Grottamare), extends a range of hills, of tertiary formation, up to the shores of the Adriatic, and is mostly covered by olive and orange groves. Some time ago, one of these hills moved to the extent of 125 paces, and passed into the sea to the extent of 25 paces. There were no other phenomena observable, save the uprooting of some trees; but a clayey substance flowed from the banks of the sea, and even, at times, from the crevices of the soil; and it appeared that an inward upheaving force, acting transvesely upward, had caused this phenomenon. Count Nerroni, who observed it most accurately, thinks that it has been caused, like the earthslips on the Rhine, by some more or less distant earthquake.

Cutting of the Isthmus of Suez.—As Austria is determined on the prosecution of the Trieste overland route, the above project has been added as an accessory stimulus. Austrian engineers have visited the locality and reported thereon. The canal is to be navigable for three-masters. 150,000 francs have been already subscribed for the study and survey thereof, and English and French engineers consulted. No shares to be made accessible to the gambling of stock jobbers.

Reorganisation of the Sculpture Galleries of the Louvre.—The King of the French has ordered that the late demise of Messrs. Clarac and Dubois should be made instrumental in re-organising the direction of the above Galleries. The collection is to be divided into the departments of classic and oriental antiques, for each of which a separate director has been appointed;—for the former, Count Laborde, the well-known traveller in Arabia; and M. Longperrier, hitherto of the Royal Library, for the department of oriental antiquities. This new *sweep* bids fair for further improvement, and it is to be hoped that those treasures, hitherto stored in the vaults and cellars of the Louvre, like the great Egyptian antiquities, the Magnesian marbles, &c., will once more see the light.

Reach of the Human Voice.—On account of the speeches of Xerxes, and others, addressed to whole armies, the question has been mooted of late, amongst antiquarians, how far the human voice can reach. It has been pretty correctly ascertained, that a man may make himself heard by 20,000 persons—a very tidy number, in many respects. And thus, taking into consideration the enclosure of walls, the acoustic construction of domes, vaults, &c.—St. Paul's, and even St. Peter's, might be filled out by a human voice—of course, a strong one, in every respect.

St. Petersburgh.—March.—Since Peter the Great's time, the character of everything structural or material the Russian Government has attempted—has been one of greatness and splendour. Thus, the huge St. Petersburgh and Moscow railway will be open for traffic in about 18 months; and at the great festival which the city of Moscow is about to celebrate in September next—viz., the seventh centenary of its foundation,—parts of the line will be available to the public.—Amongst the huge buildings, public and private, lately erected at St. Petersburgh, we may mention the new addition to the palace of the general staff (horse guards), a structure of gigantic proportions;—the palace for the officers of the ministers of justice and the Imperial domains;—the complete rebuilding of the marble palace, and the *Eremitage* adjoining the Imperial winter palace.* The new stone Neva bridge is nearly ready;—and to conclude, the gigantic church of St. Isaac (entirely of granite) is now being internally adorned, in a splendid style, which will employ the artists of St. Petersburgh of every kind for a considerable time.

Cologne Cathedral.—The latest accounts state that this structure has risen nobly during the last year. Both the north and south porch have considerably advanced; the nave begins to be covered with galleries,—and the works of the stonemasons are praised as some of the richest and finest imaginable. The number of workmen employed is 500. The restoration of this national building has excited so much interest, that an especial journal—the *Domblatt* (the cathedral gazette)—is discussing its progress. In this we find several strictures on some late proceedings of the committee, which we shall mention, for the sake of proving the correctness of the old: "Iliacis peccatur in muris." The *Domblatt* says that 16,000 dollars are to be diverted from more legitimate purposes for paving the Cathedral even now,—although, surely, this will be injured by the progress of the works, &c. Above 20,000 dollars are to be employed for roofing the whole extent of the Cathedral in a temporary manner. This, certainly, is a large sum for the prurient desire of seeing at once the whole expanse of this astounding building. The painting and gilding of the choir also (the space where divine worship is hitherto performed), is objected to.

At a Meeting of the Archæologists of the Grand Duchy of Baden, an interesting essay was read by M. Zell, ministerial councillor, on two Roman inscriptions lately found. The first was a fragment of the inscription over the public guild-house of the trade of carpenters (*lignarii*) in the Roman colony, which existed under Caracalla, 1700 years ago.

What is Style?—by Goethe;—

> Style—in art, and otherwise—
> Is, where there is no stroke
> Of either pen, or brush, or tool—
> Too much.... nor too little neither.
> Wilt thou know how difficult this be....
> Try!

* Speak then of the dwellings of British Kings!

NOTES OF THE MONTH.

French Institution of Civil Engineers.—We are happy to hear that a similar institution to the London Institution of Civil Engineers is about to be formed in Paris, under the auspices of the French Government. M. Dumon, Minister of Public Works, has devoted his attention to its formation. We most heartily wish it success.

Shakspeare Cliff.—A large slip of this interesting locality took place on Monday, March 1, when a surface of chalk 254 feet in height, and 353 feet in length (about 48,000 tons), was precipitated to the bottom. Another fall of about 10,000 cubic feet have since occurred.

St. Peter's, at Rome.—The two statues of mediæval design, meant for Peter and Paul, standing on each side of the ascending steps before the portico, but which are two blocks of shapeless travertine, are to be removed. They might have harmonised with the Byzantine taste of the old basilica to which they belonged, but were a palpable eyesore in juxtaposition with the sculpture prevalent throughout the works of Leo X. and his successors. Their limbs are stiff, their attitude awkward and clumsy, their antiquity undeniably venerable. Like many other of our time-honoured respectabilities, they have received notice to quit, and will be immediately replaced by two marble statues of somewhat different taste, from the chisels of Fabris and Tadolini, the one director of the Belle Arti, the other a scholar of Canova. These modern productions are on a colossal scale; each figure is nearly twenty feet in vertical height, though a single block from Carrara. Each cost 12,000 dollars, and both are now ready to be transported from the workshop.

New Oxford Street.—By order of the Commissioners of Metropolitan Improvements, the thoroughfare from the east end of Oxford-street and Tottenham-court-road into Holborn has been thrown open to the public. The buildings, with some few exceptions, are completed, and many of them opened for business. The roadway is macadamised, and about 70 feet in width, with a foot pavement on each side 12 feet in breadth.

Elphinstone College, India.—Mr. Orlebar, professor of astronomy, and Mr. Pole, professor of engineering, have both resigned. Indisposition is, in each case, is assigned as the reason of retirement. The charge of the Observatory has devolved on the draftsman of the Indian navy.

Rise in the Soil of Egypt.—During the course of the cadastral operations lately ordered by Mehemet Ali, it was shown that the soil of Egypt is rising each year very perceptibly, in consequence of the continued deposit left by the Nile. This elevation is calculated at 30 feet during the last century for provinces adjoining the river.

Lord Dundonald's War Plan.—We understand, says the *Hampshire Telegraph*, that the secret official trial to ascertain the effect of a continuous evolution of intense gas in projecting shells or shot from a tube, resulted, on an average, in throwing twenty-five six-pounder shot to the distance of 7,000 yards. From this data, it is clear that balls of greater diameter would far exceed the range of common artillery. Another important advantage is said to accrue—namely, that the continuous rush during their emission would prove much less injurious to vessels projecting such missiles than the shock or recoil of single discharges. We learn that Lord Dundonald's ingredients produce an elastic emission, like that which would be evolved by kindling the end of a hawser or cable formed of hard twisted gun-cotton.

Some remarks on the Air and Water of Towns, by Dr. R. A. Smith, read at the *Chemical Society*, January 4.—Having given some attention to the inquiry into the health of towns, the author was anxious to find what the real evil in the polluted atmosphere of towns consisted of; and in furtherance of this object commenced a series of examinations on the water used in the town of Manchester for ordinary purposes. Rain-water, collected in cisterns, was first examined; and on heating the solid matter obtained by evaporation, it burnt, giving the odour of fat, and a strong smell of nitrogenised organic matter. Rain collected in a clean porcelain dish, and treated in the same way, gave indications of a similar kind, but in a smaller degree. The moisture condensed from the breath contained organic matter in large quantities; and when collected from the windows of crowded rooms, it smelt strongly of human sweat during the evaporation; and when the solid residue was heated, it gave the odour of burning flesh. Water from a great number of wells situated in Manchester was submitted to examination, and in all similar results were obtained. Dr. Smith finds also that the water of rivers and canals becomes contaminated in this way as soon as it reaches a town. The proportion of nitrates is also in many cases remarkable, arising from the rapid oxidation of these nitrogenised ingredients. The author concludes by stating that he is pursuing this investigation at various seasons, so as to make a more complete examination of the subject; and the whole of the analytical results will then be given.

THE GREAT BRITAIN STEAM-SHIP.

The following reports were read at a meeting of proprietors of the Great Britain, held lately at Bristol.

"18, Duke-street, Westminster, Feb. 27, 1847.

"Gentlemen,—I beg to inclose Captain Claxton's account of the proceedings at Dundrum Bay, during the time that he has been engaged in forming the breakwater or protection to the ship, in the manner recommended by me. Notwithstanding the great difficulties he has had to contend with from almost incessant bad weather, with the wind blowing dead on shore nearly the whole of the month of January, and consequently preventing the tides from ebbing sufficiently out to allow of the work being properly proceeded with; and notwithstanding the occurrence of more than one storm at the most critical period of the work, he has, as I fully relied upon his doing, succeeded in so far protecting the ship that she has been comparatively unaffected by violent seas which, there is no doubt whatever, would otherwise have seriously damaged her. We may now calculate with tolerable certainty upon preserving her without further injury until the finer, or at least more settled, weather sets in. In the work which Captain Claxton undertook, and has so successfully completed, he has been compelled to vary very materially the mode of proceeding first laid down; he has, in fact, been obliged to adapt his plans to his means of execution, and almost from day to day to devise modes of proceeding with only the experience of the past day to guide him. Numerous unforeseen difficulties have occurred, upon which he kept me daily informed; and simple as my plan might have appeared to others, it required much skill, contrivance, and unwearying perseverance to carry out, and many alterations and improvements as it progressed. I had relied confidently on success when my friend Captain Claxton undertook the work, and the result has fully confirmed my expectations. It is now necessary to turn our attention to the best mode of removing the ship. I hope in about a fortnight from the present time to be able to give you some opinion upon this point, but it is one requiring much consideration, and until I had the opportunity of conferring with Captain Claxton on the subject, and also had before me all the measurements and data which he has collected, it was useless to attempt it.

"I am, gentlemen, your obedient servant,

"I. K. BRUNEL."

"Great Britain, 20th February, 1847.

"Dear Brunel,—The change in the wind yesterday, and the appearance to-day of more moderate weather, leads me to feel that I may with some comfort meet your wishes, by quitting this in a day or two, for a consultation. I can venture upon this step with some confidence now, in consequence of the very satisfactory result of the late heavy gales and seas upon the breakwater, after its completion on the 7th instant. I will endeavour to meet your wishes, and embody, as concisely as I can, the substance of my various communications in one report of my proceedings since my arrival on the 22nd December, when I found Captain Hosken using his utmost exertions to carry out your intentions, and I had the benefit of his assistance in trying to complete the foundation until Christmas-day, after which the tides for some days did not quit the work, and the time of the crew and labourers was entirely occupied in lashing the fagots together, in hoisting them on board whenever the water left the ship's bows sufficiently, in collecting chains and weights, and preparing the holding-down rods. On the 29th I succeeded in baying back the rivulet, as you beheld it, but which, in the very wet weather, proved to be a rapid and full-bodied stream, and which was greatly annoying us by choosing the ship's bed for its course; on that day the tide ebbed sufficiently to enable me to go on with the work, which it continued to do until the 2nd of January, when it blew a stiff gale from S.E. all night, all the next day, and with more or less force for several days after, until the sea ran so high that the surf never left the work at even dead low water and spring tides.

"About twenty bundles of fagots broke away, but, as was afterwards the case, they were picked up after the tide receded, and secured in place. On the 5th I found, on getting on the work, it had not only very much settled, or diminished in size from the pressure of the weights and the nature of the sand, but that the sheer force of the breakers had driven the whole body some feet forward. On the 6th, still finding it moving, I communicated with you respecting spars, and gave orders for preparing holding-down tackles, and such spars as belonged to the ship, over forty feet in length, to be got ready. On the 7th, it being still impossible to go on the work for any profitable purpose, the crew were employed as usual in packing together the larger bundles of fagots, and in preparing tackles, spars, &c. On the 8th, four birch spars, 42 feet long, were pointed through the foundation, with binding chains to their heels, at an angle of about 75 degs., and hove tight down with tackles to the cabin scuttles. It blew strong all night—and on the 9th, finding they had stood well, and that the weather was such as to bar us from fagoting, I settled for the delivery of 25 beech trees, of 45 feet in length, and 14 inches in diameter at the heel, with all despatch. The 10th, 11th, 12th, and 13th, the weather, wind, and tide, were still unpropitious; but on the 14th, we got some of the beech trees in place, in time to test them through a strong gale which blew that night, and all the 15th—when the tide having receded sufficiently, we laid about sixty bundles of fagots, and got a few more spars in place. On the 16th found the larger lot secured between the spars, and weighted with full four tons of iron chains, and other things, besides a quantity of large stones, had turned right over, leaving all the weights in a lump together, which I mention to give you an idea of the force of the rollers—they were as before collected and put back, and the air pump cover put upon them in addition to the other weights. On the 17th, 18th, and 19th, a little progress was made with the fagoting, but in consequence of the violence of the sea, and the want of stones, although every effort had been made to quarry and cart, we dared not put a large quantity—found what we did put sunk, shrunk, or settled each time at least three feet—this occurred four different times on leaving off as high as the screw shaft. Placing the spars still went on, but they did not conquer the inclination of the whole mass to move forward, which by admeasurement I found it had full nine feet; to check this, three tackles, with a spanner to each, with four arms for as many of the spars, were attached and hove tight to the three warps fast to the anchors out astern or on the port quarter, all the spars being attached to each other with chains. On the 20th we had a good tide, many fagots were laid, and several lighter spars were lashed laterally to the uprights, and six more beech trees were ordered. 21st, both tides happening in the dark, and the weather being extremely severe, nothing was done beyond lashing at daylight lateral spars as low as the coming-in tide permitted. On that night a heavy gale commenced from S.S.E., which only occasionally moderating, continued until the 28th, not allowing us the whole time to fagot, although, by great exertions, we were enabled to get the rest of the spars ordered in place. For a few minutes on that day we were enabled to examine the work—not a fagot had broken away, although they were a good deal jambed together—not a spar had moved from its berth, and the forward inclination was found to have stopped, although the test was the severest the breakwater had been, up to that period, put to. On the 28th the wind shifted to the westward, and afterwards to the northward; the water became perfectly smooth, and the tides excellent for our object. Every exertion was made to get on with the fagoting and placing fifteen more beech trees, which had been ordered and delivered, when it appeared so uncertain as to when we should be able to get on with the fagots. On the 7th, the whole of the fagots ordered, 4,000 bundles, were in place.

"The weather remained fine, and the water smooth, until the 13th of February, when it again changed, a heavy gale springing suddenly up from the south, which lasted until midnight. High water happening at 10 a.m., as was to be expected after such a sea, about 100 bundles of the fagots, which were only secured with chains and ropes to the screw and spars, or not loaded, similarly to those on the foundation, broke away, but the mass remained firm, although found to have settled or shrunk, or to have been beat down several feet, and jambed close against the ship. The effect, however, of the fagots and their spars was almost altogether to do away with the stroke from the sea, and the men were enabled to live on board with comfort. On the 14th it again came on to blow with the flood-tide from the S.W., and continued to do so with great violence until the springs took off, the highest of which, in the very height of a gale, was within eight inches of the memorable one which so altered the ship's position in November. The poles, lateral spars, and the fagots all held on well; and, although chafed and a good deal beat about and settled down, the latter had well done their work. I set the crew upon replacing and resecuring the few fagots which had broke away, and loading them with the best bower cable, which was unshakled from the anchor, laid out, and got on board for the purpose—preparatory to the trials which may be looked for before the March equinoxes shall have passed; and, judging by those it has already withstood, there can scarcely be a doubt of the breakwaker weathering gales of even longer duration and of a still more violent character, if it should be the ship's fate to experience such while in her present unhappy position.

"Your whole plan would have been easily carried out if the weather between the 28th of January and 13th of February, could have been substituted for that of a whole month after the 30th December; 10,000 bundles of fagots might have been secured according to your plan, with much greater ease than we were enabled to build and secure 500 bundles after the completion of the foundation, on January 7, which itself contained about 1,200 bundles, and which kept so well together, that no one felt a doubt as to the effect of the remainder, if the tides and the weather had permitted us to go on. It was extremely fortunate that you approved so early in January of the plan of using spars to assist in keeping the fagots in place, as it was not until the 28th of that month that we fairly got to work upon that portion which may be said to be about a yard above the foundation, which really contains the great mass—about 3,000 bundles; and as we were by success encouraged to extend the system of spars, at a time a fagot could not be laid, and thus not only save time and money, but form an outer protection, which was of the utmost service afterwards, and before the fagots were high up. The sea now first strikes through this barrier of beech trees and lateral poles, the former, in some places, three deep, the entire number 70 with the ship's spars, the whole fixed in the foundation of fagots, chained together at the heel, and hove tight down from their heads with tackles—about 150 spars are lashed laterally and diagonally outside of these from the sand to the ship's gunwale—the fagots, with the exception of the foundation, are all built within these, resting against the ship's side, filling the hollow of the port quarter, and as the sea is forced, with whatever violence, through the openings of this net-work of spars, which commences at the starboard quarter and extends to abreast of the mainmast on the port, or exposed side, it is received by the mass of fagots, and not only is its whole force lost as it were, but, although the spray is thrown up to the height of the funnel over the aftermast, there is no shock whatever to the ship.

"Yours truly,

"C. CLAXTON."

MISCELLANEA.

Suspension Bridge, Lambeth.—Sir Samuel Brown, the constructor of Hammersmith Bridge, Brighton Pier, &c., has offered at his own expense to construct and maintain a suspension bridge across the Thames from Westminster to Lambeth, if he can obtain the authority of Parliament and permission to establish a toll. An inquiry into the merits of the proposal has been intrusted to Captain Vetch, of the engineers,—who has entered upon the investigation, with the assistance of Captain Washington, one of the Tidal Harbour Commissioners. The estimated cost, including structure, approaches, and the purchase of property, is 90,000*l.*; but this estimate has been made on granite—and the material is now intended to be either iron or stone. The width of water at high tide where the bridge is intended to be built is 858 feet—at low water, 828. It is intended to have two piers, each of which will intercept 45 feet of water. The erection of the bridge to be finished in two years from its commencement.

Jets of Water.—Some experiments were lately made at Liverpool by the Harrington Waterworks Company, in presence of the Government Commissioners of Inquiry relative to the supply of water to the town, and is thus described by the 'Liverpool Mail':—"Short lengths of hose, with pipes of 7-8ths of an inch in the nozzle, were at-

tached to a stand-pipe from the main; and from one up to four of these branches were played for upwards of an hour,—the addition of one, two, or three, to the first appearing to make little or no difference in the respective power of any of them. The quantity of water which they projected was very great and continuous. It completely lashed the east end of the church, and not only went clear over the blockings above the cornice, and on to the roof in heavy volume, but at times ascended to the top of the flag-staff, a height, we should think, little, if at all, short of 80 feet. The plan, which combines hydraulic pressure with engine power, is decidedly much more effective than hand-worked engines; and, if adopted, will afford great and rapid protection to property in cases of fire—and that, too, with a large saving of expense."

Woolwich, March 10.—Sixteen 24-pounder gun carriages, with traversing platforms and equipments complete, have been shipped from the Royal Arsenal on board one of the Ordnance sloops for Pembroke, to be erected on the batteries for the defence of that seaport. Captain Turner's company of Royal Artillery, 6th battalion, will leave Woolwich next week for the same place, to take charge of the guns, and to mount them for use. In future, a company will be regularly maintained at Pembroke, so as to place the batteries in a state of complete defence.

The New Military Prison, erecting in the Royal Artillery Barracks, near the Riding School, is nearly completed; the main body of the building has been covered in. The prison, however, will not be appropriated for the reception of prisoners till about May next, as time must be allowed for seasoning the cells. In consequence of the great demand for labour to complete the coast defences, 110 gunners were entered lately in the Royal Arsenal as labourers.

The Coast Defences.—Northern District.—The following is the return of the number of guns mounted on the northern coast of England, from Hull to the coast of Scotland, excluding the guns ordered for the defence of the Humber. Hull citadel, seven 18-pounder guns on common carriages.—Tynemouth Castle and Clifford's Fort, five 12-pounder guns, and six 9-pounder guns on common carriages, and one 8-inch mortar; total 12 guns.—Perch Rock Battery, sixteen 32-pounder guns on traversing platforms, and two 18-pounder guns on common carriages; total 18 guns.—Scarborough Castle, six 18-pounder guns, and four 12-pounder carronades, on common carriages; total 10 guns.—Carlisle Castle, two 6-pounder guns, and one 12-pounder carronade on common carriages; total 3. Grand total for the district, 59 guns.

Lowestoft Harbour and Railway.—The timber works of the north pier, 1,300 feet in length, with the pier head, are completed, and the south pier, 1,250 feet long, is progressing rapidly. By the end of June, the harbour, it is confidently expected, will be available for ships to take refuge in drawing 15 feet water at an average tide. The work commenced last May, and there is now 2,600 feet of pier-work finished. The railway works are nearly completed, and the line will be open for goods traffic on the 1st instant. In the harbour there is upwards of 21 feet average depth of water at the lowest period of the tide, a depth which extends 100 yards within the entrance.

LIST OF NEW PATENTS.

GRANTED IN ENGLAND FROM FEBRUARY 20, TO MARCH 25, 1847.

Six Months allowed for Enrolment, unless otherwise expressed.

Joseph Clinton Robertson, of Fleet-street, in the City of London, civil engineer, for "certain Improvements in distillation and brewing, and certain applications of the materials used in, or suitable therefore, to other manufacturing purposes." (A communication.)—Sealed February 20.

Edward Brown, of Adam's Court, in the City of London, gentleman, for "certain carbonic compounds, formed of earth, vegetable, animal, and mineral rubbish, fecal substances, the waste of manufactories, and certain acids and alkalies, which compounds are applicable as manures."—February 20.

William Pidding, of Bernard-street, in the county of Middlesex, gentleman, for "an Improved process, or improved processes, for preparing certain vegetable extracts, and also for preserving the aroma of certain vegetable substances from the atmosphere."—February 24.

Charles Heard Wild, of Mortimer-street, Cavendish-square, civil engineer, for "Improvements in constructing parts of railways."—February 24.

Charles Fox, of London Works, Birmingham, for "a method or methods of welding, or uniting pieces of metal together, and of pressing or forming pieces of metal into forms or shapes."—February 24.

William Bayliss, of Bilston, in the county of Stafford, chain-maker, for "a machine for flattening and turning iron links for flat wood slub chains."—February 24.

George Russell Dartnell, staff-surgeon of the first class in her Majesty's army, now stationed at Chatham, in the county of Kent, for "an Improved truss for inquinal hernia."—February 24. Two months.

Alphonse le Mire de Normandy, of Bethnal-green, Middlesex, analytical chemist, for "Improvements in the manufacture of zinc."—February 24.

Frederick Walton, of Wolverhampton, japanner, and tin-plate worker, for "an Improved mode of coating or covering, or of coating, covering, and ornamenting the surfaces of articles which are, or may be, made of wrought iron, or of other metal or metals, which improved mode may be used in substitution of japanning, tinning, or other modes now in use of coating, covering, or of coating, covering, and ornamenting such articles."—February 24.

Juan Nepomuceno Adorno, of Mexico, in the Republic of Mexico, gentleman, for "Improvements in manufacturing cigars and other similar articles."—February 24.

John Lowe, of Manchester, engineer, and James Simpson, of the same place, joiner, for "certain Improvements applicable to carriages to be used upon railways, part of which improvements may also be used upon other roads."—February 24.

William Todd, of Holcombe Brook, near Bury, in the county of Lancaster, for "certain Improvements in the method of sizing and dressing yarns, and in the machinery or apparatus for performing the same."—February 24.

Frederick Ransome, of Ipswich, engineer, for "Improvements in working coke and other kilns, or ovens."—February 24.

Robert Snowden, of No. 7, City Road, Middlesex, tea-dealer, for "Improvements in treating or dressing coffee, to render it more wholesome for use."—February 25.

William Eccles and Henry Brierly, of Walton le Dale, in the county of Lancaster, for "Improved machinery to be used in spinning."—March 2.

John Wood, machine maker of Leeds, in the county of York, for "certain Improvements in machinery for spinning fibrous substances."—March 2.

Andrew Crosse, of Broomfield, in the county of Somerset, for "Improvements in treating fermentable and other liquids, so as to cause impurities or matters to be extracted or precipitated."—March 2.

Samuel Hunton Townsend Bishop, of Hackney-terrace, in the county of Middlesex, for "Improvements in the construction of the upper part of chimneys."—March 2.

James Napier, operative chemist, of Shacklewell Lane, Middlesex, for "Improvements in smelting copper and other ores."—March 2.

Charles Stewart Duncan, gentleman, of Lombard-street, for "Improvements in certain vehicles."—March 3.

George Tossick, engine-builder, Thomas Hackworth, engine-builder, and Thomas Elliott, superintendent of locomotives, all of Stockton-on-Tees, for "certain Improvements in locomotive and other boilers."—March 3.

Richard Roberts, engineer, of Manchester, for "Improvements in machinery for punching and for perforating metals."—March 5.

Richard Roberts, engineer, of Manchester, for "Improvements in machinery to perform the processes called beeshing, mangling, and the like."—March 5.

Amedée Francois Rémond, of Great Charles-street, Birmingham, for "certain Improvements in steam engines."—March 9.

Mathew Sproule, engineer, of Liverpool, for "certain Improvements in steam engines."—March 10.

James Stevens, engineer, of Darlington Works, Southwark-bridge-road, for certain "Improvements in apparatus for conveying signals or communications between distant places, parts of which are also applicable to lamps and burners."—March 10.

Kasimir Vogel, manufacturer, of Saint Paul's Church Yard, London, for "a new manufacture of weavers' harness, and for machinery for the production of the same."—March 10.

John Isaac Hawkins, civil engineer, of Liverpool-street, Kings'-cross, for "certain Improvements in holding together or filing letters, music sheets, newspapers, and other documents."—March 10.

Edward Johnson Coale Atterbury, merchant, of Leeds, in the county of York, for "certain Improvements in gearing machinery." (A communication.)—March 10.

James Murdock, of Staple Inn, Middlesex, for "an Improved mode of preparing and employing certain colours and materials for painting." (A communication.)—March 10.

Louis Nicolas de Meckenheim, machinist, of Birmingham, for a "certain Improvement or certain improvements in machines to be used in the manufacture of nails, screw-blanks, rivets, bolts, and pins."—March 10.

William Newton, civil engineer, of Chancery Lane, Middlesex, for "certain Improvements in engines to be worked by gas vapour or steam, either separately or in combination." (A communication).—March 10.

Henry Fletcher, manufacturer, of Over Darwen, in the county of Lancaster, for "Improvements in apparatus for ascertaining the distance which locomotive engines and carriages have travelled upon railways."—March 10.

Thomas Waterhouse, of Edgely, in the borough of Stockport, in the county of Chester, for "certain mechanical improvements applicable to railway engines and tenders, and to railway carriages of various kinds."—March 10; two months.

Sampson Lloyd, engineer, Old Park Iron Works, Wednesbury, in the county of Stafford, for "Improvements in the manufacture of tyres or hoops, or wheels or other articles to be made of iron or steel."—March 15.

Charles Fox, engineer, of Trafalgar Square, Westminster, for "Improvements in the construction of presses."—March 15.

Jean Joseph Hazard Petit, chemist, of King's Road, Chelsea, for "Improvements in the manufacture of oils, and in apparatus for disinfecting and purifying oils, and other inflammable or spiritous matters, and improvements in lamps and gas burners."—March 16.

Joseph Henry Tuck, gentleman, of Paris, in the kingdom of France, for "Improvements in apparatus for ventilating buildings, carriages, chimneys, and other places where a change of air is required."—March 16.

William Newton, civil engineer, of Chancery-lane, for "Improvements in engines to be worked by gas, vapour, or steam, either separately or in combination." (A communication.)—March 16.

Charles Tennant Dunlop, manufacturer, of Glasgow, for "Improvements in the manufacture of alkali and chlori, and in the application of the products resulting therefrom."—March 16.

Robert Scotthorn, engineer, of Somer's Town, in the county of Middlesex, for "Improvements in engines, for obtaining and applying motive power."—March 16.

James Wills Wayte, of Leeds, in the county of York, printer, for "certain Improvements in self-feeding furnaces, adapted both for land and marine purposes, for the better prevention of smoke arising from fires used in such furnaces."—March 18.

Peter Britus Coxon, of Lenton, Nottingham, machinist, for "A new method of embossing, raising, and forming ornamental figures and designs on certain intertwined textile fabrics."—March 19.

John Leslie, of Conduit-street, Hanover-square, one of the tailors to her Majesty's household, for "Improvements in the combustion of gas for the purposes of light."—March 22.

Charles Fox, of Trafalgar-square, Charing-cross, engineer, for "Improvements in the permanent way of railways, and in carriages to be employed on railways." (A communication.)—March 23.

Henry Kempton, of South-street, Pentonville, Middlesex, gentleman, for "Improvements in copying presses."—March 23.

Henry Smith, of the firm of H. Smith and Co., of Stamford, agricultural implement makers, for "certain Improvements in machinery for cutting and separating vegetable substances; also improvements in the construction of machines for dibbling, and sowing seed, and distributing vegetable substances and manure over land, part of which improvements is applicable to wheel carriages in general."—March 23.

William Bullock Tibbits, of Braunston, Southampton, gentleman, for "certain Improvements in obtaining and applying motive power."—March 23.

Henry Heycock, of Manchester, merchant, for "certain Improvements in rotary engines to be worked by steam, or other power, which said improvements are also applicable to raising or forcing fluids."—March 23.

Morris Lyons, of Birmingham, chemist, and William Millward, of the same place, silver operator, for "certain Improved alloys of metals, and improvements in the deposition of metals."—March 23.

George Fergusson Wilson, of Belmont, Vauxhall, Surrey, gentleman, for "Improvements in the production of light, and in the manufacture or preparation of materials applicable thereto."—March 23.

Henry Hatcher, of the Strand, civil engineer, for "Improvements in electric telegraphs, and in apparatus connected therewith, and also in electric clocks and time-keepers."—March 23.

Francois Stanilas Meldon de Sussex, of Millwall, Middlesex, manufacturing chemist, for "Improvements in smelting copper and other ores."—March 23.

William Bruce, of 4, Essex-court, Temple, and of Flimstow, near Pembroke, barrister-at-law, for "Improvements in constructing piers, breakwaters, and other submarine works of stone."—March 25.

ON THE MEASURES OF FORCE AND LAWS OF MOTION.

If a body be disturbed from a state of rest, or if the rate of a moving body be accelerated or retarded, the cause of the motion in the first instance, and of the acceleration or retardation in the second instance, is called *Force*. When a material particle, acted on by only two forces in opposite directions, is kept at rest, the two forces are said to be in equilibrium and statically equal. The material particle, last considered, is said to be kept at rest by the pressures of the two forces. The notion of pressure seems to arise from the peculiar sensation experienced in the muscles of the human frame, when the limbs are supporting a heavy weight or thrusting against an opposed obstacle.

By pressure, as manifested in the sense of touch, we are acquainted with the forms of all objects within our reach and grasp. If we had no other means of communicating with the outer world than by contact, our knowledge of it would be extremely limited; we could have no conception of colour, and but very little of distance; the extent of a hundred miles would be as difficult to imagine as a million with the aid of vision. These deficiencies in the sense of touch are compensated by the sense of sight—that is, by the consciousness of the presence and relations in space to each other of external objects,—as evidenced by vibrations in ether, which are communicated through the optic nerve to the brain. Hearing is excited by vibrations transmitted through the air or any other elastic matter, and which, in many instances, are so intense, as to be sensibly felt. Windows are frequently broken by the report of artillery,—and thunder, when close, shakes the walls of the stoutest buildings. We observe, then, that all our experience of the phenomena of the universe is derived from force.

Force acquaints us with the existence of matter;—nay, more, we might, with perfect propriety, consider matter as composed of geometrical points, the loci of radiating forces. In by far the greater number, however, of investigations which require the aid of mechanical science, it is sufficient to consider the properties of matter, without any reference to its ultimate constitution. Thus, having previously by experiment determined how far elasticicity, rigidity, flexibility, &c., influence the circumstances of statical or dynamical phenomena, we are enabled to solve problems involving these considerations, without any further enquiry into the nature of internal or molecular forces.

Before, however, we can apply mathematical reasoning to determine or predict what happens when any number of forces act upon a body, it is necessary that some of the effects of force should be susceptible of numerical comparison. In order to render our meaning clearer, let us, by way of analogy, consider the method usually adopted to measure heat. Heat is evidenced by many effects; among others, by the sensation of warmth,—by the impetus which it gives, when developed within certain limits, to the growth of plants,—and by its interference with the laws of chemical affinity. Yet none of these effects are sufficiently definite for the purposes of measurement. We cannot be certain that the same source of heat will always, under the same circumstances, excite the same sensations;—nay, we cannot be certain at any two times that the sensations of hot or cold we experience are the same. Still less can we avail ourselves of the effects of heat on vegetable life. While, as to the changes occasioned by a high temperature in the chemical constitution of bodies, they are involved with so many accompanying phenomena—so complex and discontinuous—that they could scarcely be compelled to furnish a scale of measurement.

There is another effect, however, of heat, which we have not yet noticed, and that is—its power of expanding the volume of bodies. This effect is rendered the more valuable by the fact, that whatever phenomena of heat are due, at any one time, to a particular temperature—that is, to a particular amount of expansion of the liquid of the thermometer—are likewise due to the same temperature at any other time. Here we have a class of effects which are always the same for the same causes, and are susceptible of arithmetical comparison—the two qualities necessary for a measure. Consequently, temperature is universally adopted as the measure of heat; and in thermotics, all the symbols and numerals have reference, not to heat, but temperature.

To return now to the effects of ordinary forces: among these, weight—or the statical effect of the force of gravity—suggests itself as an appropriate measure, not only of the gravity of different bodies, but of the pressures occasioned by any kind of forces whatsoever. By comparing the weight of bodies with the force of a spring-balance, it is found that the weight of the same body, at the same place on the earth's surface, is always the same—and independent of the position of the body in space.

Again, if we take a prismatic body, homogeneous throughout—say a cylinder of lead—and divide it into two equal parts, we shall find the weights of the two halves equal. Also, if we divide the cylinder into any number of equal parts, we shall find the weights of all these equal parts equal each to each, and the sums of their weights equal to the weight of the undivided cylinder. Let the weight of the cylinder be represented by the number w; then the weight of an nth part would be represented by $\frac{w}{n}$, and the weight of p (equal parts) by $\frac{pw}{n}$: but, as we have shown the weight of a body is not altered by dividing it into parts—consequently, the weight of a portion of lead, of which the volume is equal to the volume of the p parts, would be represented by $\frac{pw}{n}$; and its volume would be $\frac{p}{n} \times$ volume of the undivided cylinder. Hence we infer, that the weights of homogeneous substances vary as their volumes. If now we take the weight of a specified volume of a given homogeneous substance as the unit of measurement,—a force which would make equilibrium with a weight r times the specified weight is denoted by the number r: and all formulæ in statics concerning the relations of forces in equilibrio, represent each force by the number of times the unit of force must be multiplied in order to make equilibrium with it.

When we have to consider the motion of bodies, it is more convenient to employ another measure of force, the nature of which we now proceed to explain. We must first, however, define velocity. The velocity of a moving body, at any time t, is the space which the body would pass through in an unit of time, supposing the rate of the body uniform and the same as at the time t. As for example,—if 1 foot be taken as the unit of space, and 1 second for the unit of time, a body moving uniformly at the rate of 3 feet a second is said to have a velocity expressed by the number 3.

Now, it is found by experiment—First, "that if a body be at rest, it will continue at rest until acted on by some force; and if it be in motion, and acted on by no extraneous forces, it will continue in motion with an uniform velocity, and in a straight line."* Secondly, if when a body is in motion, it be acted upon by an invariable force, in the direction of its motion, the quantity by which the velocity of the body will be increased or diminished (according as the force is accelerating or retarding,) will always be the same in the same time; and is quite independent of the initial velocity which the body possessed before it was subject to the influence of the force.

This latter fact at once furnishes us with a convenient dynamical measure of force, known by the name of the measure of accelerating force. Professor Whewell well observes that the measure of the accelerativity of force would be a much better term for it. This measure of accelerating force, which, for the sake of brevity, is frequently simply designated "accelerating force," is the velocity generated in a moving body, during an unit of time, by an invariable impressed force. If the force vary with the time, the measure adopted for any time t, is the velocity which would be generated in an unit of time by the force if invariable, and the same as at the given time t: thus

* The paragraph between inverted commas enunciates the first law of motion.

gravity accelerates the velocity of a body falling in vacuo by $32_{\frac{2}{3}}$ feet a second; taking feet and seconds as units of space and time, the accelerating force of gravity is represented by $32\frac{2}{3}$.

Our next object must be to endeavour to discover some law connecting the statical and dynamical measures of motion. We are conscious, from every day experience, that the velocity we can communicate to a large and heavy obstacle by thrusting against it with all our strength, is much less than the velocity we could communicate in the same time to a smaller and less ponderous obstacle. We know that the same pressure will not always communicate the same velocity to different bodies in the same time. Let us now define all bodies to have the same masses in which the same pressure would create the same velocities in the same time. This definition of the word mass will save much unnecessary explanation in the following experiment.

Suppose n equal balls made of the same material, quite smooth, and capable, by some mechanical contrivance, of being fastened to each other at pleasure, and thus forming one or any number of solid bodies.

Let $n-1$ of the balls be fastened together and placed on a smooth horizontal table, let the remaining ball be tied to one end of a thin inextensible string, and the other end of the string attached to the $n-1$ balls. If now the e single ball be allowed to hang down beyond the table and descend, dragging the other balls after it *on* the table, and the velocity at a time t from the commencement of the motion be measured, and if the experiment be again tried with 2, 3, &c., balls hanging down, and $n-2$, $n-3$ balls, &c. on the table, the velocities at the end of the same time t will be found to be proportional to the numbers 1, 2, 3, &c.; but the pressures communicating motion were the weights of the one, two, three, equal balls, &c., and the mass moved is invariable—namely, the mass of all the balls; consequently, we learn that when the mass is constant, the velocity acquired at the end of any time is proportional to the pressure causing it—the pressure not varying with the time. Moreover, we infer that the velocity *generated* in a given time, and therefore in the unit of time, is proportional to the pressure when the mass is constant.

Next suppose that the n balls are all united, and as one mass, compelled to move by the gravity of n, other equal balls; in this case, we shall find that the velocity generated in an unit of time is the same, whatever be the value of n; consequently, when the velocity generated in an unit of time is constant, the pressure varies with the mass; and we have already shown that when the mass is constant the velocity generated in an unit of time varies as the pressure;—therefore, when both the mass and velocity vary, the pressure varies as the product of the mass and velocity generated in an unit of time. It is not necessary in these experiments that the balls should be made of the same materials, provided they be of such a magnitude that any one of them, when attached in succession to each of the rest by the inextensible string above alluded to, should generate in them all the same velocities at the same time. Since the dynamical measure of the force of gravity is the same for all bodies, it follows that the weight of bodies varies as their masses. It is sometimes assumed that the masses of bodies varies as their weights, which of course leads to the same results.

If m denote the mass of a body, g the accelerating force of gravity, the unit of mass is so chosen that mg shall $= w$, where w is the weight of the body. The property of matter by which it apparently resists a force tending to move it, in proportion to its mass, has sometimes been called the vis inertiæ,—an useless term, since it expresses nothing more than is expressed by the word mass. If v be the velocity generated in a body in an unit of time, v is the measure of the accelerating force acting upon the body: $m \times v$ is called the measure of the moving force, or more frequently the moving force, where the word force is transferred from the cause to the measure of the effect.

Consequently, when pressure, which does not vary with the time, acts directly on a body, the moving force is proportional to the pressure. In obtaining the above relation between the statical and dynamical measures of force, which is known by the name of the third law of motion, we assumed that the same pressure would generate the same velocity in any material system, provided its mass were constant, and its parts so connected that they must all have the same velocity. We assumed, in fact, that the pressure of the hanging balls produced the same velocity in the whole number of balls as it would have done on a single ball of the same material and equal in bulk to all of them.

This, perhaps, ought previously to have been demonstrated by experiment; although, in proving the third law of motion by means of Attwood's machine, most writers take the same principle for granted—as we think, most unwarrantably. Newton stated the third law of motion thus—action and reaction are equal and opposite: on this Professor Whewell observes, "since, in virtue of the equality of the action and reaction bewteen two bodies, the momentum gained and lost are always equal, the momentum gained and lost are sometimes called action and reaction, and the third law of motion is then expressed by saying that in the communication of motion reaction is equal and opposite to action."

By momentum is signified the product of mass by velocity. If we are to understand by action and reaction only the momentum lost by one body in transferring motion, and gained by the body to which motion is transferred, we do not think that there is any connection between the proposition of Newton and the third law of motion, as it is stated by modern philosophers. But in fact by the equality of action and reaction, is meant that force, whether measured by the pressure exerted or momentum lost in the body communicating motion, is productive of momentum in the body to which the motion is communicated, equal to the momentum lost, and proportional to the pressure exerted.

The principle of the equality of action and reaction is of the greatest importance: taking the statement in its most extended meaning, it enunciates not merely that in the communication of motion, the momentum gained and lost are equal, but that the internal forces connecting the different parts of a material system—provided the connection and relation of those parts continue the same—are likewise equal and opposite. We have now briefly described the various measures of force and the first and third laws of motion; the second law of motion is generally given in the following words: when a force acts upon a body in motion, the change of motion in magnitude and direction is the same as if the force acted on the body at rest. As an example of this,—If a body in vacuo were projected horizontally, it would arrive at the surface of the earth in the same time as though it had been simply allowed to fall from a state of rest. All the laws of motion are suggested by ordinary experiments; which indeed only prove them approximately, owing to the utter impossibility of excluding all forces but those the effects of which we are examining: nevertheless, in proportion as we remove disturbing causes, so do we find the results of our inquiries tend to coincide with the limiting statement of these fundamental laws. A far more accurate test, however, is furnished by astronomical observations:—the orbits of the heavenly bodies, calculated on the supposition of the truth of the laws of motion, are found to coincide with their observed orbits so nearly, that any difference may fairly be ascribed to errors of observation.

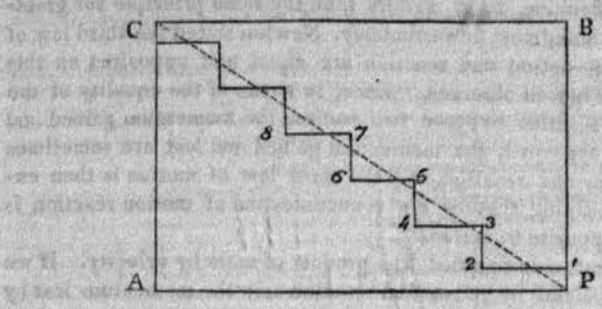
The only planet that could not be made to keep to its tables, was Uranus; the differences of its observed and predicted places were always, however, extremely small;—yet, from such data as these, Mr. Adams, previously, in England, and afterwards M. Leverrier, in France, computed the orbit of the new planet, long before its existence was announced by the telescope of the observer. In conclusion, we beg to state that we have not endeavoured to give any new definitions, or to vary the statements and terms usually employed to express the relations of force, motion, and matter; our aim has been to explain, to persons not accustomed to the terse style of mathematical works, the fundamental principles of mechanical science.

A NEW THEORY OF THE EARTH, THAT FULLY ACCOUNTS FOR MANY ASTRONOMICAL, GEOGRAPHICAL AND GEOLOGICAL PHENOMENA, HITHERTO UNACCOUNTED FOR.

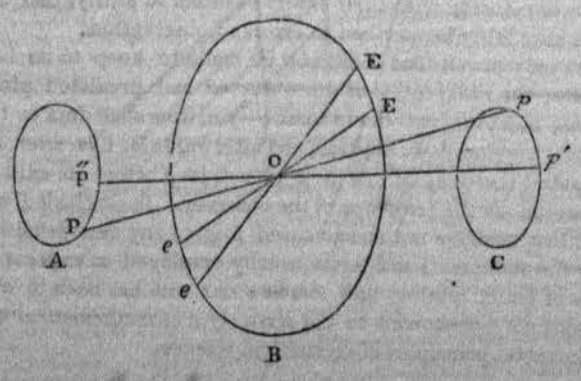
By Oliver Byrne.

(Continued from page 101.*)*

The following illustration will show, in a very simple manner, how different effects may appear to be produced by investigating causes separately, that act jointly.



Let a material point P, be acted upon by two uniform forces at the same time, in the directions P A, P B, and let the lines P A, P B, represent the magnitudes of these forces. It is well known, by what is technically called the parallelogram of forces, that it will not obey either of these forces, but the combined effect of both, and describe the diagonal P C. Now the point P, would arrive at C, in precisely the same time, if the causes of action be investigated separately, even if at every alternate instant the forces alternately act; yet the path described by P, would be very different from the true one, which the joint actions of the two forces cause it to describe. The zigzag path P, 1, 2, 3, &c., will be at best but an approximate to the true one P C. This illustration of combined action, viewed jointly and separately, simple as it is, compared with the joint actions of the sun, moon, and the other bodies in the solar system, on the excess before mentioned, shows how astronomers, by continually correcting a false hypothesis, have distorted the true motion, which we shall continue to explain. In stating that the earth's axis changes its position, we do not consider the mass moveable with it;—no; the change of the axis, which is to be understood by what is termed its *right motion*, changes the position of the equator, and, therefore, the latitudes of all places. It may be necessary to remark here, that the *right motion of the earth's axis* is very slow; so much so, that scarcely any perceptible difference in the latitudes can be observed in 100 years,—chiefly on account of this motion not being recognised in a proper manner, which has tended to baffle the theory of corrections, now so dissatisfactory. For the purpose of exemplification, we shall show how this motion of the earth's axis would cause the phenomena of a precession of the equinoxes. This may be shown by simply allowing the poles to change their position in two opposite circles. It may be necessary also to remark that this supposition is made merely for the purpose of illustration, for the right motion of the earth's axis is not in a circle, but in a looped spiral curve of double curvature, the nature and properties of which are given in the proposer's new work on the Theory of the Heavens and Earth, before alluded to. However, when this supposed plain motion is understood, *the right motion of the earth's axis* (which at once effects these apparent motions, recognised by the terms precession, nutation, and the decrease of the obliquity of the ecliptic,) can readily be conceived. If a right line P p, be supposed to revolve about its middle point O, in such a manner as to describe a circle A P P″; the other point p, will describe an equal circle, whose plane will be parallel to that of the former circle. The lines P p, P″ p', &c., will have the same inclination to the plane passing through O, parallel to the planes of these circles. Now, if a plane be supposed to pass through O, perpendicular to P p, and intersect the plane E B e, in E e, when the point P, moves to P″, the plane perpendicular to P″ p', passing through O, will intersect the plane E′ E B, in E′ e'; so that if P p, P″ p', &c., be considered consecutive positions of the earth's axis, the plane of the ecliptic to be E B e, and the variable plane passing through O, perpendicular to P p, P″ p', &c., the plane of the equator, then the consecutive points E E, &c. show the precession of the points where the planes of the equator and ecliptic intersect, and how their positions are changed with the motion of the poles P p. A motion similar to this, but of a more compound nature, causes what is technically termed the precession of the eqinoxes. Now, the spiral motion, or rather change of the earth's axis, above alluded to, which is chiefly caused by the influence of the sun and moon on the excess of the earth above its greatest inscribed sphere, is what we have designated *the right motion*, or *change of the earth's axis*. The nature of this motion can be readily conceived from the apparent phenomena of precession, nutation, &c. Hence, this exposition shows that the earth has but three motions; namely, one round the sun, one on its axis, and a change of that axis; the nature of this last motion or change is something similar to that which is observed in a globular body spinning on an horizontal plane. However, the change of the axis in this globular body is only calculated to give an idea of the uniform change of the axis of the earth, caused, as we have before observed, by the constant and commanding influence of the sun and moon. As the poles shift their positions on the surface, so does the equator and the protuberance there; and, in fact, every particle of which this globe, if we may so term it, is composed, endeavours to accommodate itself to this motion, so that the earth's true form is that which may not be improperly termed an exvoluted spheroid, continually, but slowly, changing its relative position. To guard against any misconception, it may be necessary to state, that the change of the protuberance at the equator, or rather the change of the excess of the earth above its greatest inscribed sphere, is not a sliding of that excess over the inscribed sphere, but the establishing of another and another excess in different positions, in consequence of the change of the position of the earth's axis, which is continually being changed by the influence of the sun and moon on the excess existing at any time. Every particle, internal and external, natural and artificial, is influenced by this motion. The sturdy edifices of man soon moulder down, or their foundations are depressed or elevated: the true cause is never assigned. When no local cause can be trumped up, all is left upon what is commonly termed the ravages of old time, which lets nothing alone.



The changeable protuberance or excess is said to be about 34 miles more in diameter at the equator than the diameter through the poles;—this slow and constant change of the excess of the earth above its greatest inscribed sphere, has done more in baffling the observations of man, and all his inquiries respecting the nature and figure of the earth, than any other circumstance which might be named. If the earth were composed of one uniform substance, ready to accommodate itself to the behaviour of this change of protuberance, the true motion of the earth's axis would have been discovered long ago. The heterogeneous substances of which this planet is composed, and which are more and more changed with respect to colour, pliability, and form, with their varied positions by the influence of heat and cold in the great laboratory of nature, must in a greater or less degree, in every instance, point out the existence of this unerring law. The change of this protuberance, or rather the change of all the particles with respect to the imaginary line about which this planet makes its daily revolutions, although very slow and gradual, effects a change in the whole heterogeneous mass, every instant, more or less, according to the pliability of the several parts; those parts which do not instantly change, from the rigidness of their nature, ultimately feel its sway: so that the earth would become, from what we have termed the right motion of its axis, a figure whose nature and proportions could be readily determined, were it composed of one yielding and uniform substance; but on account of its heterogeneousness, and the rigidity of some of its component parts compared with others, this figure, which we shall here designate an exvoluted spheroid, becomes in parts more or less slightly indented or elevated, according as these parts and those surrounding them are more or less sensitive of the constant disturbing cause. Not only a change in the inanimate kingdoms is effected by the right motion of the earth's axis, but also a constant change in the animate: it is not asserting too much to say, that the

gradual decline of nations is mainly to be attributed to the same cause; for this change, by its powerful influence, leaves places more or less suitable for the habitation of man and other animals. In the words of the justly celebrated Dr. Charles Hutton, "amid all the revolutions of the globe, the economy of nature has been uniform, and her laws are the only things that have resisted the general movement. The rivers and the rocks, the seas and the continents, have been changed in all their parts, but the laws which direct those changes, and the rules to which they are subject, have remained invariably the same." The following facts and statements may tend to illustrate this theory. The gradual change of the fixed stars, especially that which is termed the north pole star, (Ursa Minor) with respect to the apparent north and south, shows that the axis of the earth is continually changing its position; this fact is not disputed, but the parallels of latitude on the surface of the earth are supposed to remain fixed, which is by this theory controverted. In the "Boundehesch," a work containing the cosmogony of the Parses, and supposed to have been written by Zoroaster, it is said that Ormusd formed the light between the heavens and the earth; that he made the sun, moon, and stars, and divided the latter (probably those near the ecliptic,) into twelve constellations. Each star in the zodiac is said to be seconded by 6,480,000 smaller stars, and all these are represented as soldiers, ready to make war on the enemies of nature. Ormusd, it is added, has also placed in the four quarters of heaven, four sentinels to watch over the stars; of these Taschter guards the east; Sateris, the west; Venand, the south; and Haftorang, the north. There is said to be, also, a great star Meschgah, in the midst of heaven, for the purpose of giving further protection to the south when the enemy comes in great numbers. Now it is impossible to form an opinion what can be meant by this enemy so mysteriously announced; but the designation of the stars seems to correspond with the *Host of Heaven*, which is used in the scriptures, and with the attendants or guards of the Supreme Deity, which is the denomination applied by the Egyptians to some of the constellations and planets; and it has been attempted by modern astronomers to prove that four of the principal fixed stars were really situated in, or near, the four cardinal points of the horizon about the year 2200 B.C., which is the period assigned to the first Chaldean observations. D'Alembert remarks that the longitude of Aldebaran, at that epoch, was 11° 20′, and its latitude 5° 30′ south; and as Antares differs from Aldebaran in longitude by six signs, and has 4° 30′ south latitude, it follows that these stars were then very nearly in the points of the vernal and autumnal equinoxes; consequently, one of them would be seen to rise near the east about the time that the other was setting a little to the north of the west. Now, it has been alleged that Taschter signifies the genius presiding over rain, and we know that the heliacal rising of Aldebaran was considered by the ancients as an indication of approaching storms; hence it is, with some propriety, inferred that this star and Antares were two of those alluded to in the Persian story. The other two stars are less certain, *the right motion of the earth's axis not being recognised;* D'Alembert supposes they might be Fornalhunt and Regulus, which were then nearly in the plane of the solstitial colure, and the former would be visible in the south at an altitude of about twelve degrees above the horizon of Babylon, while Antares and Aldebaran were respectively rising and setting: but Regulus must have been 34° below the northern point of the horizon, supposing the axis not to change; consequently, according to this theory, Regulus would be visible at the same hour in that latitude. If, therefore, continues D'Alembert, it was meant that the four stars were at once seen in the situations just mentioned, we must look for some other star having the same longitude as Regulus, but having at least 34° of north latitude;—the * *r* in Ursa Major is so situated, and it is possible that this might be the star in question. M. Bailly observes, "that the notion of the four stars quartering the heavens seems to have extended to China, for in the History of the Astronomy of the Celestial Empire, it is said that there are four spirits which preside over the four seasons, meaning probably the quadrants of the Zodiac, and it is likely enough that this kind of observations would be made by any people among whom astronomy was in its infancy."

This general apparent change of all the fixed stars, in pointing out the motion or change alluded to, is much baffled from the dissatisfactory theory of corrections, from the rise and fall of all places in accordance with the change of the excess before alluded to, and from the very slow motion of this excess: another thing calculated to lead the observer astray, is the fixed opinion that the latitudes of places are never altered. It would appear that all astronomers and philosophers of every description had made up their minds to change everything before they would allow the latitudes to change, although such a change is shown to exist, whether the subject under consideration be astronomical, geological, or geographical.

The latitudes of ordinary places may differ from time to time, in a greater or lesser degree, from the inaccuracy of instruments, observations, or measurements; but it ought to excite a suspicion to find the latitudes of observatories changing, where oversights have no possible chance to enter into such a simple problem as the determination of the latitude. Now, it is a noted fact, that every astronomer in Europe counts his observatory to be in a different latitude from that of any of his predecessors, if such have had a predecessor; even astronomers called Royal, in enlightened England and France, differ respecting the latitudes of their respective observatories given by their several predecessors, but their differences are sure to be saddled upon any cause except the true one—the actual change of the place with reference to the poles. These facts are so well known, that it would be useless to give a list of the latitudes in which the several observatories have been said to stand.

It would likewise be useless to state the different latitudes which have been given to the same remarkable places on coasts and elsewhere; these were changed without the slightest compunction, as time could not be spared for them to undergo the like cookery which the latitudes of observatories have undergone.

Not only the change of the latitudes of objects and places show this change in the earth's axis; but among many other observed facts, we may here mention the foundation of all our old churches, which were laid out due east and west, and due north and south, have shifted to comply with the right motion of the earth's axis, and that too in direct proportion to the dates of their standing. One of the most remarkable instances of this kind that has fallen under our notice is that presented by the position of the city of Philadelphia, in the United States of America. The surveyors under the direction of William Penn, the founder, laid out Market-street and Broad-street, crossing each other at right angles, due east and west, and due north and south; but now they point in different directions, accommodating themselves to the universal law which is here for the first time shown to exist.

If we are to admit that the particular positions of the temples at Denderah and Esneh, in Egypt, were really given by design, we shall hardly be able to avoid concurring with Dr. Stukely in that part of his hypothesis concerning the Druidical monuments at Stonehenge and Abury, in Wiltshire, which relates to the direction of their longitudinal axis. The former of these is well known to consist of a great number of prismatic stones, placed on end in the peripheries of four ellipses, whose major and minor axes are respectively in the same right lines; the entrance is supposed to have been at one extremity of the major axis, and opposite to it, within the area, is a stone which seems to have been used as an altar. The doctor's opinion is that the founders of the monument intended to place it in a direction tending from nearly the south-west to the north-east, and to place the entrance opposite the latter point of the horizon, in order that it might receive the first rays of the rising sun on the day of the summer solstice; it being, he observes, the custom of the ancients to celebrate their great festivals at that season. The principal part of the work at Abury consists of one great range of stones, enclosing a circular area, within which are two double circular ranges, respectively concentric with each other, but neither of them having its centre coincident with that of the former and containing circle. A line joining the centres of the two double circles is also supposed by Dr. Stukely to have been intended to coincide with that joining the north-east and south-west points of the horizon; but he observes that in the temple at Stonehenge, the axis deviates 8 or 9 degrees southward from the north-east points; and in that at Abury, the line of the centre lies about 10 degrees northward from the same point. Now these different deviations, which are by Dr. Stukely supposed to have resulted from the employment of a mariner's compass to determine the directions of the axis of the temples; the needle being subject to a variation which is different in different ages, and the priests of the country being supposed to have considered, erroneously, that it coincided in direction with the *true* meridian of the place.

We conceive it unnecessary to offer any argument to disprove the latter opinion, that these monuments were *oriented* by means of a mariner's compass, it being highly improbable that such an instrument would be used for that purpose, when the heavens present so many phenomena by which the end might be gained with much more ease and accuracy. Among other objects which can be submitted to actual measurement, may be mentioned sun-dials of long standing, especially horizontal ones, as they partake of this motion in a two-fold manner—that is, with respect to the elevation of the gnomon and the gradual change of the horizontal plane. Many instances of this kind are on record:—sun-dials excavated from the ruins of Pompeii and Herculaneum do not now tell the hour in the latitudes in

which they have been found; if any person would take the trouble to compare the time which such dials now show, with that time which they ought to show, they will find that the earth's axis must change in the manner which we have described. It may be supposed, because the bearings of natural objects, such as the tops of mountains, do not change in exact accordance with the motion of the earth's axis, like the foundations of churches and other structures of man, that such a law has not an equal influence over them: the fact is, that the rigidness of the materials of which they are composed not only prevents them immediately yielding to this motion, but also leaves them elevated or depressed, either gradually or suddenly, above or below the rest of the surrounding matter. This theory is borne out by many phenomena, but it is our intention first to test it by those which are capable of being submitted to actual measurement.

It is borne out by actual measurements which were instituted in different places, in order to determine the figure and magnitude of the earth. For this purpose, the lengths of small arcs were measured in different places on the surface of the earth, with the greatest care; but, for want of a true theory of the earth, their measurements, for the purposes for which they were instituted, were almost useless, and led to very dissatisfactory conclusions. Although these measurements disappointed the measurers, in pointing out the form which they supposed the earth to be before they commenced their operations, yet their results are of the greatest use in supporting what is here promulgated. We cannot avoid remarking here, that the plans upon which all our great measures of the earth proceeded were very injudicious—that is, first supposing the figure to be one form while they were carrying on their operations, and when finished affirming it to be another: besides, they give way as much as possible in all their measurements and calculations to their preconceived opinions, despite of all the natural exponents which pointed to the contrary. The values of the degrees of latitude found at different places on the earth's surface differ from each other more than might be expected, considering the great attention that has been paid to ascertain and make allowance for every known cause of error. In France, the lengths of the degrees were found to go on diminishing from north to south, but not in a regular progression. In England, on the contrary, they were found to diminish from south to north: so that if the figure of the earth were to be deduced from the degrees in the former of these countries alone, it would appear to be oblate; if from the degrees in the latter, it would appear prolate. As might be expected, the lengths of degrees measured in the northern hemisphere of the earth deviate, within certain small limits, from the values they should have on the surface of any conjectured figure, except the one which we have described. The degrees measured in corresponding latitudes in the opposite hemispheres also disagree;—this fact, as a matter of course, must necessarily follow. The proportions between the equatorial and polar diameters of the earth are, necessarily, stated to be various; the comparison of the arc measured in France with that in Peru (in which last, it should be remarked, the observations of Bouguer were made use of,) gives, for that proportion, 334 to 333; D'Alembert, taking a mean of the observations of Bouguer and La Candamine, afterwards found it to be as 309 : 308. The length of a degree in India, compared with that in England, showed the ratio to be as 329 : 328.

The ratios $\begin{cases} 318 : 317 \\ 314 : 313 \\ 289 : 288 \end{cases}$, and many others, have been given at different times from the same sort of measurements. The difference in these ratios instead of showing that they are all wrong, shows the exact contrary,—that they are all very nearly correct: which increases the number of observed facts that support the phisico-dynamical demonstration.*

That the earth is slightly indented or exdented in different places, appears at once from the different magnitudes which actual measurements point out: if it were otherwise, no matter whether it was supposed to be spheroidal, ellipsoidal, or any other solid, formed under a uniform law, except the form which we have here designated "an indented and exdented evoluted spheroid," the difference could not have been so great;—so that, although the right motion of the earth's axis, or rather the slow but constant change of the position of the excess of this planet above its greatest inscribed sphere, exercise its influence on all the particles of which it is composed, yet some of them for a time remain unaltered, from their rigidness,—but, ultimately, all must give way, or be covered by the ocean, which is always ready to obey this general law of nature.

The late trigonometrical surveys show, either that the latitude of places have changed, or that they were greatly misplaced by former surveyors. Now, it is more likely that the places have changed their positions with respect to the true north and south points, than that errors of such magnitude could be committed; one of the principal objects of trigonometrical surveying being to determine the geographical positions of principal or noted places, whether on coasts or inland, in islands or on continents, in order to give accuracy to maps, and for the purpose of accommodating navigators with the true latitudes and longitudes of principal promontories, lighthouses, havens, and ports. It is well known that these have, till lately, been requirements even in this country: the positions of some important points, as the Lizard, not being known within seven minutes of a degree; and the last survey found the best country maps in many cases to exhibit differences of more than three miles in distances of not more than twenty or thirty miles. The late surveyors may attribute all this to blunders made by their predecessors; but this is not at all likely, as the rudest instruments or the most careless observations could not so far mislead: in one hundred years from the present time, the same apparent blunders will be again detected. There is nothing which might be named that baffles the observer more, in determining the longitude either on land or at sea, than the erroneous opinion that the latitudes of places remain always unchanged. The whole face of nature points out this universal change;—geologists not having recognised it is astonishing: their conflicting and contradictory theories respecting the formation and structure of the earth, by this theory are set at rest for ever.

The chemical influence of heat and cold, combined with the gradual change of all matter, at once accounts for the several observed phenomena attributed to so many causes. By the right motion of the earth's axis, or rather the change of the excess so often alluded to, we have, among others, the following natural consequences:—Rivers appear to bury themselves in the earth, or rather, the places rise through which they flow. Mountains, which do not immediately give way to this change of surface, from the rigidness of the substance of which they are composed, ultimately, often without the slightest warning, decrease in altitude many feet. As this protuberance shifts its position, it only disturbs the particles, but in a very slight degree changes their respective distances;—for instance, it is not to be imagined that the particles of one valley co-mingle with those of another. In the ocean, islands appear and disappear from the same cause. Continents, as well as islands, are increased in some parts and diminished in others, and that in such a regular manner that the influence of this general law is at once recognised. The structures of man, as well as those of nature, are often instantly elevated or depressed. Countries, which were once fruitful and thickly inhabited, have become barren; and, on the contrary, those which were barren, become fruitful. This motion not only changes the beds of rivers, but those of oceans and seas, so as not to show the same levels in places only a few miles distant—that is, with respect to what is erroneously called the mean level of the sea. Mr. Whewell has fallen into errors in his account of the theory of the tides, from his not having observed this general law of nature. In fact, the true cause of the motion of the waters on the surface of the earth, is mainly to be attributed to this motion. The sea-worn pebble obtrudes through the caverns of the deep and appears on the surface of the earth many miles from the sea, mixed with marine substances and remains of shell-fish. Fossil remains are found many feet from the surface, and in different climates from those to which they belonged,—often imbedded in substances which are evidently deposits, assuming different appearances from pressure, position, and being submitted in the great laboratory of nature to the different changes of temperature, and other local causes. It is not difficult to conceive how transformation can take place, for in the laboratory of the chemist the most durable substance is easily made to pass from a dense to an aeriform state, and the contrary;—water on the surface of the earth affords us daily a familiar instance of this, in its three separate states of rock, fluid, and vapour. The varying spinning motion of the earth on its axis, which is continually changing the excess so often mentioned, has this effect on the particles that compose the ocean; they are daily and hourly obliged to accommodate themsevles to the behaviour of this motion, and also to the constant change of the less pliable substances over which they are compelled to move: therefore, to imagine that the ocean can have a mean or uniform level, as Mr. Whewell and many others do, is absurd. But this is satisfactorily shown by a comparison of the observations made on the tides in different ports and places. Slow as the right motion of the earth's axis appears to the shortsightedness of

* In consequence of an Editorial note, annexed to the first part of this article, it is necessary for me to state that the mathematical demonstration of this problem is given in my work on the Calculus, which is being printed, and will shortly be published. In due time my analysis shall be published, together with a concluding article on the "Strength of Materials," a subject fully discussed in my forthcoming work, just mentioned.

O. B.

man, yet, were it to cease, the earth would be shortly deluged. Not only the particles of the ocean, but of the air, are subject to its influence,—the magnet acknowledges it, and every particle composing and surrounding this heterogeneous mass. If geographers, geologists, and astronomers look at the constant changes which take place on the surface of the earth, and in the appearance of the heavenly bodies, in accordance with this general law of nature, they cannot for a moment question its existence.

ON THE MEASUREMENT OF WATER DELIVERED THROUGH LARGE (OR WIDE) ORIFICES.

By M. MORIN.

(Communicated to the Academié des Sciences, Paris.)

In experiments on hydraulic motive powers, the most delicate portion, and that most subject to error, is the measurement of the quantity of water expended. Local circumstances, forms, or shapes, the arrangement of flood-gates, exert on that quantity great influence, which, as yet, has been too little studied, and the inexact appreciation of which has frequently led the most conscientious observers into serious errors, to which may be attributed, very frequently, the manifest exaggeration of certain results announced with the most perfect sincerity.

In order to avoid such errors, and to establish with some certainty, or at least with a sufficient approximation to it, the ratio of useful effect produced by the motive powers submitted to experiment, to the absolute amount of water expended, I endeavoured to determine upon a mode of measurement beyond the reach of controversy, which was somewhat difficult.

For this purpose, I first reflected whether I could measure, with sufficient exactness, the quantity of water supplied by an overshot-wheel sluice fixed at the head of a channel or race, in which the motive powers to be subjected to experiment were to be placed.

This sluice is equal in width to the head-race, constructed of masonry; it is inclined from above downwards at an angle of above 65 degrees to the horizon; its upper edge has an acute angle up-stream, and is rounded off down-stream; it is 3 inches thick. Two racks, each of 2 inches wide, reduce the clear width to 6 ft. 7 in.

In order to estimate the volume or quantity of water that passed over this sluice, the tail-race, which was constructed of masonry, with a rectangular section, was closed below by a vertical dam of plank, in which were made three openings; to these were fitted sluices of about 0·300 m. (1 foot) square, of thin sheet iron, of about 0·005 m. ($\frac{2}{10}$ in.) in thickness, sliding in front of the orifices, which were formed with sharp edges. These iron sluices were, by means of screws, worked by hand; rods with marks showing the level, were placed in front of the overshot-wheel sluice and the iron sluices, in order to show and to verify the invariableness of the levels.

From this short description, it may be readily conceived that by making simultaneous observations at the overshot-wheel sluice, and at the regulating orifice, the supply, or quantity delivered by the two kinds of orifices, might be calculated, by means of the very precise results of the experiments of Messrs. Poncelet and Lesbros, and which were evidently applicable, with all desirable exactness, to the case in question.

But these experiments, undertaken on canals of great dimensions, which had vast basins, subject to the effects of the winds, and whose level it was difficult to regulate perfectly by means of an ordinary mill sluice, could not possess a degree of exactness comparable to that of experiments made under more favourable circumstances. In order to examine into the whole together, and to disengage the results from accidental influences, we have re-produced them by a graphic construction, taking the values of the *charge* (or head of water) H, on top of the sluice, as abscissa, and those of the co-efficient of the supply or delivery as ordinates.

In examining the table of the results, and, above all, the curve which represents them, it is seen that the values of the co-efficient of the supply or delivery increase rapidly with those of the *charge* H, on the ground-sill of the orifice, from H = 0·03 m. (12 inches), and 0·04 m. (15¾ inches), up to H = 0·10 m. (4 inches), a term beyond which they still continue to increase, but more and more slowly.

If, to compare these results obtained with a sluice of 6 ft. 7 in. in width, equal to that of the head-race, and placed in the before-mentioned circumstances, with those which relate to a sluice of 0·20 m. (nearly 8 inches) wide, to complete contraction, we determine, by means of the figure, the values corresponding with the *charges* observed; in this last case, the following table may be formed, which is limited to the *charges* with which we have operated:

Width of Orifices.	Values of the co-efficient m, of the formula $Q = m\,L\,H\,\sqrt{2\,g\,H}$, For the values of H equal to					
	0·04 m.	0·06 m.	0·08 m.	0·10 m.	0·15 m.	0·20 m.
0·200 m.	0·407	0·401	0·397	0·395	0·393	0·390
2·017	0·264	0·355	0·418	0·448	0·469	0·482

It is seen that for small *charges*, this sluice of 0·08 m. (3 inches) thick, produces a notable diminution in the supply or delivery, although the contraction may be nearly annulled on the vertical sides of the orifice. This effect is analogous to that observed by Messrs. Poncelet and Lesbros on small overfalls passing through a shute. We know, in fact, that, in the cases in which the contraction is nearly null on the sides, these observers found the following values of m:

Charges on the upper side of the overfall.	0·04 m.	0·06 m.	0·10 m.	0·15 m.	0·21 m.
Values of m.	0·246	0·271	0·308	„	0·324

These values, which, for small *charges*, made a very near approach to those we have obtained, show that the diminution of the supply or delivery depends, in both cases, on the same cause—on the resistance of the side or wall of the sluice, or of the shute. We notice, in fact, that in small *charges*, the fluid vein wets and follows the surface of the sluice; but in proportion to the increase of the *charge*, this influence of the sides or walls diminishes, and soon, indeed, the fluid vein detaches itself completely from the upper edge, which is sharp up-stream, and the resistance of the surface of the sluice ceases to be felt, whilst at the same time the suppression of the lateral contraction continues to exert an increasing influence on the augmentation of the supply or quantity delivered; whence it results that the co-efficient of the supply or delivery increases.

Such is the natural and simple explanation that may be given of the smallness of the values of the co-efficient of the supply or delivery for the small *charges*, and of their magnitude for the large *charges* observed in our experiments.

Notwithstanding the care taken in the execution of these experiments, the local causes and circumstances mentioned did not permit us to approximate nearer than $\frac{1}{15}$th or $\frac{1}{20}$th; but the sketch shows, nevertheless, by taking them as a whole, the gradual and continual progress of the increase of the co-efficient of the supply or delivery, and, until new and more precise researches are made, I think we may, in applications to analogous cases, adopt with sufficient accuracy for practice, the values deduced from the sketch, for the co-efficient of the supply or delivery, viz.:—

Charges on the Sill of the Overfall,—in metres.

0·04, 0·05, 0·06, 0·07, 0·08, 0·09, 0·10, 0·12, 0·14, 0·16, 0·18, 0·20,

Values of the Co-efficient m.,—in metres.

0·264, 0·313, 0·335, 0·390, 0·418, 0·437, 0·448, 0·460, 0·467, 0·472, 0·477, 0·482.

These values, which, for *charges* exceeding 0·10 m. (4 inches), are much greater than those which have been, up to this time, adopted for similar cases, show that sluices, arranged like that made use of by us, which is the case with many horizontal wheels, deliver more water than is generally admitted to be the case; and that, in experiments on hydraulic motive powers, we are liable, for want of a good method of measurement, to estimate the supply or delivery of water at one-sixth or one-seventh below the real amount, and, on the other hand, very much to overvalue the useful effect.

Experiments on an Orifice with the Charge on the Summit.

Although the *ensemble* of the results obtained with the overshot water-wheel sluice, enables us to determine with sufficient exactness, at least for practice, the amount of water actually supplied or delivered in the experiments proposed, on hydraulic motive powers, I have thought it best to make use, for this purpose, of an orifice with the *charge* on the summit, so that the height, and, consequently, the

area of the orifice remaining the same, the *charge* on the centre, being alone exposed to slight errors of measurement, enters into the calculation of the supply or delivery, but as under a radical of the second degree, and the influence of these errors diminishes when the *charge* increases.

For this purpose, I caused to be made on the same race or canal, an orifice of 1·496 m. (4 ft. 11 in.) in width, the vertical sides of which were 0·16 m. (6·3 inches), and 0·165 m. (6·5 inches) from the sides of walls of the canal, and as the movements or risings of the sluice were very slight, when compared with these distances, the contraction might be considered as nearly complete on these sides, as well as on the upper and lower sides.

The determination of the actual supply or delivery by this orifice, was made, as has been before explained, by means of a small iron sluice, whose greatest opening was 0·300 m. (12 inches).

The examination of the results obtained, and above all, their graphic representation, show that the greatest deviations did not amount to more, and were almost always less, than $\frac{1}{40}$th of the ordinates of the curve which represents them. And as, for experiments on hydraulic motive powers, such an approximation is quite sufficient, we have been able, in the ulterior calculations of the supply or delivery of water, to adopt the values of the co-efficient of the supply or delivery deduced from this very curve.

We wish it to be observed that, in our experiments, the *charges* on the summit of the orifices having been comprised between 0·050 m. (2 inches) and 0·180 (7 inches) at farthest, and that this dimension, agreeably to the experiments of Messrs. Poncelet and Lesbros, producing an influence, at most, of only $\frac{1}{72}$, the variation of the co-efficients has scarcely depended on any thing except the height of the orifices.

We have therefore been enabled, in accordance with this remark, to seek to compare the values of the co-efficient of the supply or delivery which we have found, with those which have been determined for equal heights of orifices of 0·20 m. (8 inches) in width, by Messrs. Poncelet and Lesbros, and we have thus formed the following table:—

Nature of the Orifices.	Values of the co-efficient of the theoretical supply or delivery for height of orifices of		
	0·20 m.	0 ·10.	0·05 m.
Orifice of 0·200 m. wide,	0·592 m.	0·611 m.	0·630 m.
„ 1·496 m. „	0·675 m.	0·679 m.	0·727 m.
Increase owing to the augmentation of width,	0·083 m.	0·068 m.	0·097 m.
Or,	·100 m.	·100 m.	·100 m.
	8·130	10·900	7·530

It is seen that the width of the orifice appears to have had a considerable influence on the supply or delivery, and that the increase resulting from it for this supply or delivery has varied, in the cases in question, from $\frac{1}{7\cdot3}$ to $\frac{1}{10}$.

These results prove how necessary it was to verify beforehand the exactness of the formula to be made use of for the measurement of the supply or delivery of water, since differences of this kind might result from it.

We will moreover observe that these results, giving amounts of supply or delivery much greater than might have been calculated agreeably to the rules generally admitted, the useful effects obtained from the motive powers studied in the experiments of which we have to give an account, will be diminished in the same proportion, and that, in this point of view, our results will be less favourable to them than if we had been content to follow the ordinary rules.

Evaporation of Water.—A paper was read at the Academy of Sciences, Paris, respecting the quantity of heat annually applied to the evaporation of the water on the surface of the globe, and of the dynamic force of the streams of continents. M. Daubrée asserts that the evaporation employs a quantity of heat about equal to one-third of what is received from the sun, or in other words, equal to the melting of a bed of ice of nearly 35 feet in thickness if spread over the globe. The motive force of the streams in Europe is, according to M. Daubrée, equal to between 373,508,974 and 364,678,620 horses working incessantly during the whole period of the year.

ON M. BRUCHHAUSEN'S NEW THEORY OF THE TELLURIC FLUCTUATIONS OF THE SEA.

By Professor MADLER, of Dorpat.

Our globe presents an abundance of evidence, that its present condition is one which did not exist in times anterior. It is the purport of the present time to establish these facts and their corollaries, historically and empirically, and to frame the way for their genitic elucidation; while the purport of the future will be to penetrate into their genesis, and to elucidate, in an incontestible manner, the first causes,—whereby the existing effects and results may be proved and demonstrated to perfect evidence. We do not intend, by saying so, to discredit all present endeavours to arrive at these first causes of our globe-nature;—every endeavour in this respect is meritorious.

This apology we have to premise to our review of M. de Bruchhausen's (of Luxembourgh) theory of sea-motion, first communicated to the congress of *scientiates* at Bremen, and subsequently developed in an especial work. Its general features are as follows:—

1. If masses of iee become fixed on the bottom of the sea, they cause a preponderance of that hemisphere whose pole they form,—and, in consequence of that preponderance, the centre of gravity of the globe must change its place.

2. Ice masses of this kind are fixed as well at the south as at the north pole, but are not immutable, but increase and decrease alternatively.

3. The fact, especially, that in a cycle of 21,000 years, the poles, have their summer in the peribelium and aphelium (by which, also a difference in the duration of seasons is given)—causes a disparity in the proportion of evaporation and precipitation, and consequently, a greater increase of the polar ice-masses on that pole which possesses, then, the shorter summer; as well as a decrease of those masses on the opposite pole.

4. In consequence of the shifting of the centre of gravity, caused by the increase and decrease of these masses, the sea must move to that pole where the bottom-ice is increasing,—flood the land there, and lay dry those on the opposite pole. Thence, so little land exists now on the southern hemisphere, and such breadth of land porects towards the pole on the northern.

These condensed statements will suffice for testing their plausibility. M. de Bruchhausen himself, considers the third argument the weakest, as the observations of Herschel (whose correctness is not disputed by M. B.) have proved, that the sum of the temperature of summer, is not changed by the different position of the Apside line. Still, the distribution of heat over single seasons is, certainly, somewhat—albeit, not much—different; and could, possibly, be the cause of an imperceptible increase of the polar ice. We say possibly, because such a complicated phenomenon demands the most accurate physical inquiry,—which M. Bruchhausen has not made, but endeavours to prove his position by induction.

In this place already, the objection can be raised, that an alternate increase and decrease of ice-masses (at least, as their limits are concerned,) takes place every winter and summer,—as, naturally, the winter pole will have more ice than the summer pole. If this difference were of sufficient quantity to act in the way put down by the author,—then, during every summer, we should observe a flowing from the north hemisphere southward; in winter, one in an opposite direction. The elevation of the continents and islands of the temperate and frigid zones, would be different in summer and winter. As, however, such a periodical change of the level of the sea (every year) is, surely, not observed,—then, also, the still lesser difference of aphelic and perihelic summers, is also incapable of producing such astonishing difference of the level of the ocean, which the author estimates at 20,000 feet. This difficulty cannot be obviated, even if the effect of this action be extended to several thousand years.

The same result will be arrived at by a simple calculation. Let us assume the extent of the polar ice, at an equal distance from the pole, at merely 15°; and as Weddel has sailed up to 74°, and Ross even to 78°, south latitude, we might safely consider it even as more. Let us further consider the curve of its surface (independent of the curve of the globe) as being parabolic: let us take the density of the polar ice at 0·86; the density of the globe, according to Bailly's latest experiments, at 5·69; and let us express the thickness of the bottom-ice at the pole by x;—then the shifting of the centre of gravity of the globe thereby produced will be:

$$= \tfrac{1}{2}\,\frac{0\cdot86}{5\cdot69}\cdot \sin.^2 15^\circ . x = \frac{1}{394}\,x.$$

Whence it results, that for shifting the centre of gravity of the globe only one foot, a mass of ice will be required, which has a thickness of

394 feet at the pole, and reaches (on all sides) up to 75°,—being fixed at the bottom of the sea.

As, however, the opposite pole does not loose its bottom-ice, which (according to M. Bruchhausen's theory) is merely diminished—the assumed shifting of $\frac{1}{301}x$ is obviously too great; and if the two masses of ice are in the ratio of 1 : 2, it is to be reduced one-half. At any rate, even supposing these masses to be of the utmost thickness, the shifting will turn out to be quite imperceptible, and inadequate to produce such phenomena as the author wishes to explain thereby.

After saying so much, we hardly wish to inquire whether there really be ice-masses of the kind at the poles, or whether they be subject to such great changes and variations. The new antarctic continent, discovered by recent travellers, which rises with its volcanic peaks to the height of 12,000 feet, does not seem to allow of the assumption of such mighty masses of ice—and the same seems to be the case in the north. But even abstracting from these lands, the theory of M. Bruchhausen will vainly endeavour to point at any possible shifting of the centre of the globe's gravity.

In regard to the phenomena which the author endeavours to explain, it is easy to perceive that they do not tally with his theory. He refers to some upheavings observed on some littoral parts of the northern hemisphere. But this is quite a local occurrence—for while the coast of Sweden is rising, no such thing takes place on the shores of Denmark, England, or even the Prussian or Russian territories of the Baltic. Against this upheaving in one part—depressions, at no great distance, are observable—as, for instance, the whole coast of Dalmatia is descending, and the once market-places of several cities, like that of Zara, are now flooded by the sea. In other parts—such where cities three thousand years old are to be met with—all has remained *in statu quo*. The triangle of Sicily has been the same since remotest antiquity, all the old ports of the Mediterranean are the same; although, since their first foundation, nearly one-third of that period has elapsed in which the poles change their position—as far as the Apside line is concerned. All this proves sufficiently that the elevation of Scandinavia and the depression of Dalmatia, as well as other phenomena of the same kind in other parts, are merely of local character; and it is not the level of the sea which has changed, or ever can change,—but the land which, from epoch to epoch, is shifted like the scenery of some huge theatre. If there were really any such cause or agency, as the author supposes, a simultaneous elevation of one hemisphere, conjointly with a depression on the other, would take place, whose extent would only depend on the Sinus of the latitude.

We think that this simple statement will convince M. Bruchhausen and other investigators, that his labours have taken a wrong direction—as will those of any one, who will attempt an explanation of geological phenomena by astronomical agencies, both being perfectly distinct—at least, only confluent on their extreme limits. Because, while astronomy has to deal with space and matter of immense and hugest extent, geology is the doctrine of a thin crust of one of the most puny points in the great system of the *Cosmos*.

J. L——Y.

Bridge over the Rhine at Bâsle.—M. Edouard Krafft, a young engineer, who has distinguished himself by the building of several cast-iron bridges, and especially by that of Aspach, near Muhlhausen, has made a proposal to the corporation of Bâsle to build a new bridge, instead of the present old one, whose clumsy and unsightly form disgusts every beholder. M. Krafft proposes to obviate the great difficulties which present themselves, by introducing improvements in the laying of the foundation, hitherto only resorted to in mines. The principal improvement proposed by M. Krafft consists in placing the piles in the bed of the river by means of immense bells of sheet iron, of the shape of the piles, into which a steam engine would constantly pump air. This would enable the workmen to execute, even at a depth of 10 mètres below the level of the river, all the operations of excavation, the ramming in of the piles; the laying of the beton, and the masonry. The bells, whose upper part would be higher than low-water mark, would be cut at that height, after they had been filled up with masonry, and would remain (serving as a case for the latter) in the water. This work would supersede the cofferdam system (?), and save 30,000 francs per pile, besides offering an hitherto unprecedented degree of safety. The corporation of Bâsle has purchased M. Krafft's plan, which bids fair for its ultimate execution.

SANITARY REGULATIONS OF THE METROPOLIS.

If anything more worthily distinguishes the present age—notwithstanding Coningsby's outcry about the age of tinsel and brass—notwithstanding the charge of Mammon worship and the imputations of selfishness—it is the spirit of practical improvement, exemplified not merely in undertakings which are reproductive to the community and profitable to the conductors, but in those daily and long-continued exertions of the Government and the educated classes, for the amelioration of the condition of all members of society, and in particular of the condition of those who, from want of intelligence and want of means, are least qualified to help themselves.

It is well to assume the attitude of *laudatores temporis acti*; to speak of the good old times; to banish virtue to the annals of antiquity; and, in denying modern merit, to lament modern depravity. That is an old vice; it is aptly characterised by the Sage of Judea and the Poet of Rome;—and it is one so tritely known among ourselves, that it must argue some confidence in the extent of public credulity, to try it on any large scale in our times. Have we all forgotten the classic scene in the "Spectator," where the shrewd observer takes down a book from the shelves of his library, and reads to the grumbler an awful description of the depravity of the times? "How true," says the grumbler, "how accurate—how minute!" And yet the page of the moralist did not refer to the time of Queen Anne, but to that of Henry the Eighth. In the time of Queen Victoria, a large school, with the Coming Man at their head, and Pugin for their Michael, cry out on the worthlessness of the present day, and sigh for the middle ages, the forms of which they would fain revive among us. To copy the merits of our forefathers, to catch their noble spirit, is well worthy of our ambition;—but to adopt their system bodily, and to eschew all the merits and improvements of the present day, would be as insane in practice as it is antic and fantastic in suggestion.

If, however, there be one party who would drag us back, body and soul, to the middle ages, there is another who, for self interest, would oppose every improvement in the present day: so that no suggestion can be made for any practical measure, without its being met by the most violent outcry and misrepresentation. Such is the fate which has beset Lord Morpeth's bill and the sanitary arrangements.

None can have a more superstitious horror than we have of Government interference—none have been more consistent in their opposition to any unjustifiable attempt at extension of power and control. On the Steam Vessels question, our humble exertions were sufficient to frustrate the objectionable designs of the Board of Trade. On the proposition of the Buildings Act, we co-operated in obtaining the removal of the obnoxious clauses; and we cannot charge ourselves on any one occasion with neglecting the interests of the public or of those professional readers who favour us with their confidence. We cannot, however, go so far as to object to all Government interference, or to deny that it can be properly exercised; for we have ourselves, on many previous occasions, in reference to this present question of the sewage and sanitary arrangements of towns, exercised what influence we possess in the exposure and correction of the very serious abuses which are still so greatly prevalent.

We might sympathise with those who objected to the Government obtaining the sole control over the sanitary arrangements of the metropolis; but knowing what we do of the sewage, drainage, paving, cemeteries, and supply of water in the metropolis, and having so often had occasion to write in terms of disapproval, we cannot consistently say that the present system requires no alteration,—for we must say that it requires a great deal, and that Lord Morpeth's bill in that respect errs only in not going far enough.

We defy any sensible man to look at the wretched and confused mode of administration, the number of conflicting local boards, the host of useless and inefficient functionaries, the opposition and antagonism shown in the details of arrangement, and the miserable and contemptible results,—we defy any man, we say, to consider these things, and not feel ashamed that in the greatest metropolis of the world, and among the most practical and business-like people, such a disgraceful state of affairs should exist,—whereby the public money is wasted, the public wants are neglected, and the public health is endangered.

On this point all opinions ought to agree—that the local boards should be abolished, and the administration simplified: common sense requires this, if economy and public justice did not imperatively claim the reformation of the present abuses.

This point conceded, an efficient working must follow, which is mainly prevented not by the want of capacity of the local officers employed, not

by their want of professional skill, but by the want of power to carry out the most essential improvements and the best conceived designs.

If we look at the state of the sewage of the metropolis, we are sure all must agree that its present condition is bad, and that even the worst Government board could not be worse. The metropolis is split up among several irresponsible boards, exercising independent jurisdictions, and acting on the most discordant principles. While the upland is under the Finsbury and Holborn Commission of Sewers, the outfall is under the City of London Commissioners. The Tower Hamlets Commission take charge of the East of London, sending some of their drains into the Finsbury division. The western parts of London are delivered over to the Westminster Commission of Sewers, who have the Crown Commissioners for Regent-street and the Regent's-park interfering with them throughout. The southern suburbs belong to the jurisdiction of the Surrey and Kent Commission.

The result may be anticipated: as there is no central authority, there are repeated conflicts between the jarring functionaries,—for the divisions embracing districts of undulating surface, have not, in all cases, the command of their own outfall, or have not the command of the natural outfall. Hence, circuitous lines of sewer are adopted, to the great inconvenience of the public, and to the great loss of the rate-payers. The Regent-street and Regent's-park district, which is under the Woods and Forests, runs right up in a narrow strip through the Westminster division, from Scotland Yard to the Regent's-park, and has its own main sewer and its own separate outfall. The consequence is, that the Westminster Commissioners, instead of sending some of their northern drainage into the Regent-street main sewer, have recourse to a long detour, by a sewer of two miles in length, to join the King's Scholars' Pond Sewer, higher up the Thames.

Proceedings of this kind are fraught with mischief and injustice; for not only have the Westminster Commissioners to contend with a very slight inclination, and a very bad outfall, through the King's Scholars' Pond Sewer, but a great deal of money is wasted in the original outlay for the circuitous sewer, there is always a difficulty in keeping it in order, and there is necessarily a much heavier charge for its repair. The Regent-street sewer is one of great capacity; it is carried to a considerable depth, and is sufficient to drain all Westminster and Marylebone,—and yet a new and needless sewer has, under the present system, been made.

There is also, from the nature of the boundaries, some difficulty in securing the proper cleansing of the sewers by flushing; for the Westminster and the City of London divisions of sewers have not within their districts access to a sufficient supply and head of water. Under a combined system, reservoirs of water would be formed at Hampstead, Highgate, Hornsey, and on the northern range of hills, and would be applied to properly flushing and cleansing out the sewers and drains in the lower divisions of the City, Holborn, Westminster, and the Tower Hamlets. In the Holborn and Finsbury division, the flushing plan is well carried out; but there is no reason why, by proper arrangements, the same facilities should not be generally and economically applied.

It is also very well known, that until a very late period, from want of a proper control on the part of the public, and from want of exertion on the part of the functionaries, the greater part of the sewers in the metropolis were constructed on improper principles, and in a wasteful and insufficient manner. This was particularly the case in the Westminster Commission of Sewers, and we believe we may claim some part of the merit—as having been to a considerable extent effected by our exertions—that the new sewers are being carried out in a manner, much more economical, much more efficient, and much more satisfactory. The present surveyor has done a great deal to lessen the expense by laying down oval sewers, and by giving sewers of a small size to courts and alleys he has extended the accommodation without increasing the outlay. Indeed, almost as much has been done as perhaps can be done, by the formation of small oval drains and the introduction of pipes, to make the construction of sewers as cheap as it can be,—so that our objections are not made on that ground. It is with regard to the proper direction of the sewers, and their proper application, that the greatest deficiencies are felt; and these are so serious, and have lasted so long, that we can place no confidence in the present system for their efficient and final remedy.

We have already said so much on these points (particularly in our Journal for 1843, vol. VI., p. 43), that we are almost disinclined to say any more,—except that being obliged to go over the same matter four years afterwards, and to contend with the same opponents, we cannot escape the repetition. Those who will refer to Vol. VI., p. 43, will find that we have gone as minutely into the subject as we can, and particularly in reference to Mr. Donaldson's defence of the Westminster Commission of Sewers; which, however, furnished us with ample evidence as to the defects of the present system, or rather want of system, and the necessity for its entire reform.

We cannot recapitulate all that we then said, but we may usefully avail ourselves of some of the evidence which we then adduced. We showed, on the authority of Mr. Donaldson, that in consequence of the want of unity of action, very large sums had been expended in rebuilding the main sewers and deepening the outlets. Thus, the Essex-street sewer, between 1816 and 1836, was lowered throughout a length of 5800 feet, or upwards of a mile. The eastern branch of the Hartshorn-lane sewer, likewise in the Westminster Commission, between 1831 and 1839 was lowered throughout a length of 4200 feet; and another branch of the same sewer, between 1820 and 1837, throughout a length of 3400 feet. The whole of the King-street sewer was, before 1832, lowered on a length of 1200 feet, and the Wood-street sewer, the College-street sewer, and the Horseferry-road sewer, were also lowered. Thus, in one division—the Westminster division—the great extent of 21,450 feet (or 4 miles) of new main sewer has been constructed. Of this we should not of itself complain, if the whole system were not faulty, and if, instead of merely rectifying old errors, the new works did not, as we have already shown, involve further errors.

The works on King's Scholars' Pond Sewer are so heavy and so extraordinary, that Mr. Donaldson and others look upon them with a great degree of pride, as involving the application of much skill and ingenuity to overcome the difficulties with which the surveyors had to contend. Thus, the driving of the new sewer, for 550 feet in length, and at a considerable depth, was carried on from withinside the sewer, and an inverted arch was constructed, and the old obstructions removed; the works being carried on under buildings, and having been considered impracticable by John Rennie, Jessop, Chapman, and others. In some parts of its course, this sewer was driven under courts narrower than itself, and frequently below the foundations of contiguous buildings, without inflicting injury upon them.

It is scarcely credible, that works so expensive and so difficult should have been undertaken without any adequate necessity; and yet such is the fact, for, as we have already shown, the Regent-street sewer is amply sufficient for the drainage of the district; and, by the use of it, the enlargement, or rather reconstruction, of the King's Scholars' Pond Sewer might have been avoided, and the drainage carried to a shorter and more effective outfall.

The works in the City of London Commission have been, to a great extent, of the same character as in the Westminster Commission, having been directed to the formation of new outfalls, not for their own drainage, but for that of the upland districts. Under a proper system, the expense of the outfalls would fall on the whole district, and the outfalls would be properly adapted to the extent of duty which they have to perform.

The Westminster Commission, among others, long persisted in the use of flat sides to their sewers, though frequent failures occurred in their application, and they were expensive and cumbrous in construction, while there was adequate experience that the oval form of sewer adopted in the Regent-street and Holborn divisions was of greater solidity, was less expensive, and better calculated to secure a quick drainage. Naturally, the great object in sewage is to get rid of noxious waters as quick as possible; not to keep them penned up, festering among the dwellings of the people, but to discharge them with the utmost speed. This, the Westminster form of sewer was not calculated to effect; while the oval form was perfectly competent, as the investigations in our Journal, and the subsequent adoption of our views, have fully proved.

A comparison of two classes of sewers, in the Westminster and Holborn divisions of sewers, under the old plan, will show how wasteful was the expenditure under the former system.

In these calculations, the cost of materials and labour being taken as the same in each case, at 1s. per foot reduced, or £13 12s. per rod of brickwork, and 1s. per cubic yard for digging, strutting, and filling-in or removing the surplus ground; the top of the sewer being taken as six feet below the surface of the ground.

Westminster first-class sewer: 17 feet brickwork, 17s.; 3½ yards digging, 3s. 4d.;—total . . . . 20s. 4d.
Holborn and Finsbury first-class sewer: 12 feet brickwork, 12s.; 3 yards digging, 3s.;—total . . . 15s. 0d.

This shows a difference of 5s. 4d., or more than 30 per cent.

Westminster second-class sewer: 15 feet brickwork, 15s.; 3 yards digging, 3s.;—total . . . . 18s. 0d.
Holborn and Finsbury second-class sewer: 9 feet brickwork, 9s.; 2½ yards digging, 2s. 4d.;—total . . 11s. 4d.

This shows a difference of 6s. 8d., or between 50 and 60 per cent.

A Holborn first-class sewer used to cost less than a Westminster first or second class—being, in fact, 20 per cent. cheaper than the Westminster second-class sewers. It is, therefore, scarcely conceivable that the monstrous waste of money involved in carrying out the Westminster mode of construction should have been so long persevered in.

The worst feature, however, in the present administration of the sewage is, that it is virtually inacessible to that class of houses which most require drainage; and it is no exaggeration to say, that the dwellings of the lower classes in London are left without drainage. Very expensive and very well constructed main sewers and secondary sewers are laid down, but so far from being applied to drain the dwellings, it is as much as they do to drain the surface of the streets and roads. This arises from the commissioners of sewers carrying their labours no further than the streets, leaving the householders to make the communications with the sewers.

We were going to say that the commissioners left the householders to make the communications at their own expense with the main sewers, but that would scarcely represent the true state of the case, for the fact is, that the householders can only make a communication by exposing themselves to heavy pains and penalties. The regulations of the commissioners in most districts require as much expense to be incurred in carrying a drain up to a house, as in laying a sewer in a small street, and the result is that sewer drainage is a luxury unattainable by many of the middle classes, and the majority of the mechanics and of the poorer classes.

A most expensive main sewer may run within a few yards of a house, but the outlay required for running a drain into it is so large, is so disproportioned to the necessity of the house, and so exorbitant in reference to the means of the landlord and the extent of the rental, that the idea of incurring such an expense is given up as hopeless. The consequence is that numbers of houses have cesspools, and in the closely crowded houses in the small courts and alleys, it may be taken as the general rule that there are no water closets, that fetid waters are kept on the premises, that noxious miasma is as it were hoarded up, and all the appliances of fever are held in readiness to tell with fatal effect among a population, whose careless and improvident habits readily predispose them to the attacks of infectious disease. For such a state of affairs, so fatal to the poorer classes and so dangerous to the wealthier, the commissioners of sewers must be held accountable; and no remedy can be considered effectual until such a system is adopted, as will make it incumbent on the officers of sewers to provide adequate drainage for every house, rich or poor, and give medical men and officers of health the efficient means of removing evils which they may deplore, but cannot prevent.

We have already stated in the pages of the Journal that the charge of the Westminster Commission of Sewers acted as prohibitory on fourth-rate houses within their jurisdiction, the charge being 10s. per foot. This charge of 10s. per foot is made on the length of the frontage of the house for permission to be allowed to enter one of the commissioners' sewers, built at the expense of the public; and if it be a corner house, the commissioners will not allow it to be drained at all into the sewer, although there is a public one within 12 feet of the house, and will compel the party to build a new sewer along the front of the house, and be at the expense of an expensive connection with the old sewer. The whole expense of forming this sewer and a drain for one fourth-rate house would cost at the least 15*l.* to 20*l.*, being 10 per cent. on the cost of the house, which might be done for about 2*l.*, if the commissioners would allow the house to be drained into the existing sewer. This is not a supposed case, but one which has actually occurred within the Westminister district, so that parties considered it their duty to construct cesspools to avoid an excessive outlay. By requiring each house to have separate drains, at whatever distance the house may be from the sewer, the charge of a heavy drain is seriously aggravated, whereas in many cases one drain would be sufficient for two or even for three houses. In fact, what is the difference between allowing such a practice, and running an inferior sewer up a small court into which many short drains are allowed to be made?

We wish some member of the House of Commons would move for a return of the length of all the sewers which have been built, rebuilt, or repaired at the expense of the public by the commission, their cost, and the actual number of houses on each side of the sewer which drain into it, and the number which do not, distinguishing courts; if we are not very much mistaken, this return alone would upset the present commission, and would show that these commissions do their utmost to obstruct the drainage of the metropolis, and consequently to injure the health of the inhabitants. What we contend for is, that if the commissioners are obliged to construct a sewer for public purposes, that all the houses on each side should be allowed to enter it, for, generally speaking, where the commissioners do build a sewer, it is through an old district which has been paying sewer rates for many years: for instance, a sewer has been built in High-street, St. Giles's, by the commissioners, and although the houses on each side have been paying rates these 50 or 60 years past, they are not allowed to drain into it, without paying a fine of ten shillings per foot frontage.

If the management of the sewage in the metropolis present such a state of affairs, what can be said of the paving boards? It is bad enough to have half-a-dozen commissions of sewers, each of which embraces a large borough or many parishes; but the paving boards in many cases have not even the jurisdiction of a parish or a borough, but some parishes are split up among a score paving boards, each separate estate having its own paving and lighting boards, its own set of commissioners, and its own set of officers to take charge of the paving, lighting and cleansing of a narrow confined district. The nuisance prevails to such an extent, and the want of organization is so strongly felt, that it is most extraordinary that it should have been submitted to so long. If Lord Morpeth should let the commissions of sewers alone—though we do not see why he should—there ought at any rate to be a consolidation of the paving boards, either into a central board or borough boards. At present, the City of London is the only district having a consolidated board, which is also that of the commissioners of sewers, and nothing has occurred in the working of that board to show its inferiority to the labours of the score or more boards, who mismanage the affairs of districts not greater in superficies, nor of more importance in extent of traffic.

It is stated, that besides the City of London Commission and the Regent-street Commission, there are no less than 84 different boards having the management of the paving in the metropolis. In the parish of St. Pancras alone there are no less than 16 different boards. In Kensington there are ten boards, in Lambeth there are seven boards, in Newington Butts six, in Whitechapel six, in Bermondsey five, in St. George's, Southwark, four, in St. Andrew's, Holborn, four, and in Shoreditch, four.

Some boards have only the management of the highways, some only of the lighting.

Altogether there is such a confusion that the commissioners themselves in some cases scarcely know what they are about.

Of course, each of these boards has it own commissioner, its own clerk, its own surveyor, and its own rates, and it is easy to determine what must be the consequences,—that while the ratepayers are overcharged for such an establishment, the officers are inadequately remunerated. Instead of liberal salaries being given to parties of competent abilities, miserable stipends are allotted to those who now discharge the offices, while the public are not thereby benefited.

That it is requisite to have eighty-six clerks to boards and their subordinates, we cannot conceive that any one will take the trouble to affirm; while their reduction would leave a well-paid staff, and effect a large saving.

The surveyors and assistants attached to eighty-six boards would, no doubt, be reduced in number, though perhaps not to such an extent as the clerks, while the re-appointments would secure a large and efficient body of officials, with a graduated scale of liberal salaries; giving a stimulus to merit, and holding out an adequate reward for long services.

We are sure that the surveyors of the City of London, of the Woods and Forests, and of St. Marylebone, are not worse paid than the surveyors of such petty districts as Ely Place, the Saffron Hill Liberty, Tothill Fields, the Brewer's Estate, the Lucas Estate, or the Harrison Estate.

Under the present state of affairs, it frequently happens that the commissioners of sewers or of paving are restricted in their powers of useful action, or imagine themselves to be so, and as the cost of amending a local act for a small district is considerable, they are often virtually debarred from the official discharge of their duties. This is one of the many circumstances consequent on their small and limited jurisdictions. Some of the commissioners of sewers consider that they are not empowered to do anything else but to repair old sewers,—all concur that they have no effective powers to make drains to houses, or to take necessary measures for the preservation of the public health.

There is nothing in the management of these paving boards, which can

be considered at all favourable to their pretensions of fulfilling their duties. They are virtually irresponsible in the discharge of individual duties, and individuals are powerless against them; while being appointed by popular, and often by party election, they will take no measures, which by increasing the rates, may secure a better state of affairs, but endanger their tenure of office.

It is scarcely possible to walk down a main street without seeing the various tastes of these gentlemen exhibited in the shape of specimens of granite, macadam, wood, or asphalte, in every variety of form, often so badly constructed as to endanger the lives and limbs of passengers and cattle, and always in such a filthy condition as to be a serious and objectionable nuisance. By the dirty state of the streets and roads, the houses are bespattered with mud, and shopkeepers are deterred from adopting light and expensive paintings and decorations. The dust created is blown into the houses to the deterioration of books, linen, and furniture, and in the case of tradesmen, to the very considerable injury of their stock. As to passengers, in summer their eyes, mouths, and nostrils are filled with dried horse-dung under the name of dust, and in winter their clothes are spoiled by the accumulations of mud; whereas, under a proper system, it has been practically shown, there is no reason why even the most crowded thoroughfares should not be kept clean, summer and winter.

Upon the waste of manure which takes place in the metropolis, we will not dilate. It suffices that it is disgraceful to a practical country like this, that such large resources should be lost to our agriculture.

We must say, that if an amalgamation of commissioners is to take place, we can see no reason why it should not include the metropolitan roads and the county bridges, which should certainly not be separated from the jurisdiction of a competent authority.

We are free to admit, as we have already said, that it may be a matter of question how far Government control should extend, but we do not think, on a fair and impartial investigation, there can be any doubt that a consolidation should take place under one body of the jurisdictions for draining, paving, lighting, and cleansing the metropolis.

Whether that should be under a Government board, or whether under an elective board, we are not prepared to determine, though each would have its advantages and disadvantages.

A Government board would be virtually irresponsible, and would involve the disposal of a considerable amount of patronage, over which at the present time no effectual control could be devised.

An elective board might want unity, might court popularity by avoiding the discharge of disagreeable duties, and might dispose of its patronage if not for political purposes, at any rate for jobbing purposes.

Some of the evils of an elective board might be readily cured by making the election, not annual, but for a period of four years, thereby securing a certain degree of permanence of character in the board, and at the same time leaving each member at a proper period to answer to his constituents for the discharge of his duties. At present, the commissioners of sewers are irresponsible, and no Government board could be so bad in that respect.

An amalgamated board might be formed from representatives of each great division of the metropolis, those from the City of London being named by the corporation, and those from the large divisions, as St. Pancras and St. Marylebone, being named by the vestries. There could be no more difficulty in electing members of such an administrative and representative body than in electing guardians for poor-law boards, and we know of no objection to the adoption of such a course.

Under such circumstances, the distribution of patronage would be less obnoxious, and would most probably be faithfully complied with.

If such an elective board were formed, there should be no controlling power on the part of the crown, for that would destroy the energy and responsibility of the board without transferring it elsewhere. We should, however, be disposed to allow to the Crown a complete power of inspection, which for all practical and useful purposes would be quite as effective as control, and would bring the proceedings of the board within the cognisance of parliament.

At all events, whatever may be our views as to the parties with whom power should be intrusted, we have no doubt it is for the interest of the public, and for the interest of architects, engineers, and surveyors, that the general principles of Lord Morpeth's bill should be adopted and carried out.

THE ROYAL ITALIAN OPERA, COVENT GARDEN.

One of the most important architectural events of the season has been the reconstruction of Covent Garden Theatre, as the Royal Italian Opera. This has been executed under the direction of Mr. Benedict Albano, hitherto better known as an engineer, in which profession he has already acquired much reputation among us. The transition from flax-mills, steam boats, and railways, to an Opera-house, is a sudden, perhaps a violent one, but Mr. Albano has shown that in the fine arts and the useful arts he has equal powers of design and execution.

Covent Garden was previously known as one of our largest theatres, but it did not afford the extent of accommodation required by the new lessees, and Mr. Albano therefore laid before them three plans, one by which it would have been transformed into the largest theatre in the world, surpassing San Carlo and La Scala, a second smaller than those theatres, and a third which, though it gave additional tiers of private boxes, left the theatre of its original size. It is the second plan which has been adopted, though we wish, for Mr. Albano's sake and our own, he had been allowed to eclipse our foreign rivals, and redeem us from Byron's old reproach of inferiority to theatres which will each accommodate nearly 4000 persons.

The old Covent Garden Theatre, it will be remembered, was constructed by Sir Robert Smirke, after the fire in 1808. He, also, wished to have a larger theatre, but was overruled by John Kemble, who was fearful that if the theatre were larger nobody would be seen or heard. Sir Robert's object was therefore to construct the smallest possible interior or auditory within as large an available exterior as possible. His interior stood against fire and harm during the long theatrical generation of nearly forty years, but has succumbed at length, before the hand of Mr. Albano, to an unhappy fate, that of the destruction of works, which is likely to attend Sir Robert Smirke, as it has Sir John Soane. Sir Robert modelled his building, according to his statement, on the Parthenon at Athens, and the exterior possessed considerable merit.

We must now proceed to give what sketch we can of the building, though we cannot go into any detail, in consequence of our engravings not being complete for the present number, which prevents us from making the necessary references to illustrate our description.

It must be observed that the great design has been to convey the idea of grandeur and imposing magnitude, and this has been most skilfully carried out; while all that constructive skill could do, and all that attention to comfort demanded, has been completely effected.

The plan having been settled, Mr. Albano proceeded to pull down the whole interior of the audience part and parts adjoining, and to re-arrange it. He has thus been able to get an enormous auditory, and a grand range of saloons with suitable approaches.

In the grand front, beyond what we have already noticed, the chief alteration is the carrying of a carriage-way beneath the portico, whereby visitors are saved the annoyance of getting out of their carriages in the wet, and the street approaches are widened.

On entering by the grand front, a magnificent hall and staircase attract attention. These are decorated with columns painted in imitation of Sienna marble, and lighted from lofty bronze candelabra.

At the head of the staircase is a range of saloons level with the grand tier, and 130 feet in length. Preceding these is the Shakspeare room, with a statue of the poet; the next is the ante-room communicating with the saloon or crush-room, forming three compartments by means of Ionic columns, and with a quantity of large mirrors on the walls. As the walls are papered with green, the gilding produces an exceedingly good effect, while comfort and luxury are consulted in the ottomans and couches.

On entering the theatre, it is seen that its dimensions are on a very large scale, as to height and breadth. The breadth between the boxes, 60 feet diameter, is particularly striking, and also the extreme height of the house. The pit has been sunk, and the tiers of boxes now rise six in number, forming a colossal amphitheatre of unaccustomed proportions.

The dimensions of the house are 80 feet from the curtain to the front of the boxes, and 60 feet in breadth between the boxes, and the width across the stage between the columns of the proscenium 46 feet.

The ceiling is one of the attractions. Its dimensions are 70 feet by 62 feet. From the centre depends the enormous chandelier, one of the largest in England, and which is almost the only source of light to the house. It consists of several rings of light, and twelve clusters of twenty to five-and-twenty jets, producing the most brilliant light, while the reflection and polarization of the drops and pendants increase the picturesque effect. The

ceiling itself represents the sky, and is of peculiar form, partly elliptic and partly hyperbolic, so as to be in conformity with acoustic principles. It is also coved all round. We may note, too, that the proscenium forms a splayed arch, so as to throw the voice into the centre of the house. All that could be done to make the house a good hearing house has been effected.

The ceiling is in keeping with the decorations of the house, of which the leading colours are white and gold, here and there set off with a slight turquoise blue. The relieved ornaments are all in the cannabi composition, which admits of the gilding being highly burnished. The whole effect of the decorations is chaste and picturesque, while, by the boldness of the proportions, grandeur is preserved.

We may note that the ventilation has been the subject of the special care of the architect, and in which he seems to have attained much success.

The approaches to the house have all been re-arranged, separate entrances being provided to the royal boxes, to the boxes and stalls, to the pit, and to the gallery, with fire-proof staircases. The details in every part are also so arranged as to give the greatest comfort, and to enable a large audience conveniently to sit through a long performance, as well as to hear perfectly. This is really as great an advantage to the actor as to the hearer, as, without it, due attention cannot be paid to any representation, however skilful.

While we cannot withhold our testimony to the solidity of the construction, having inspected it in detail, we are bound also to notice the rapidity with which the alterations were completed, the old interior having been pulled down, and the new one erected from the foundations, within four months. This is a great feat, performed by Mr. Albano; and we must state that great credit is due to Mr. Holland, the builder, and Mr. Ponsonby, the decorator, for the rapid manner they have executed the work. The brilliancy of the gas also, it is to be observed, is due to the use of Mr. Low's patent for napthalizing t.

STATE AND PROSPECTS OF FRENCH RAILWAYS.*

One of the greatest advances that has yet taken place in the progress of European civilisation is slowly but surely approaching in the comprehensive system of railways in course of construction in France. The object of the following review is rather to glance rapidly at the present position of French railways than to dwell at any length on the reflections that naturally present themselves on entering into the consideration of such a subject.

Paris to Rouen.—The first line that comes under our notice is that from Paris to Rouen, opened for traffic on 1st May, 1843, being the first of the French railways, in chronological order, which was completed to the north of Paris. It is eighty-four English miles in length, and was constructed from the plans of Mr. Locke, the engineer of the South Western Railway. The present net returns are about 8 per cent. on the capital, and the receipts which were 8,832*l.* from passenger traffic, and 3,722*l.* from goods traffic in January, 1844, were respectively 10,038*l.*, and 14,693*l.* in the same month of the present year. The extension of this railway, 57 miles in length, from *Rouen to Havre*, is completed, and opened last month: it has occupied a long time in construction, from the numerous works of art necessitated by the uneven character of the country through which it runs: among others, six important viaducts, one of which—that at Barentin—fell down shortly after it was completed, about fourteen months ago, and has since been rebuilt. There is also a bridge over the Seine, at Rouen, about 1,200 feet long. This line will complete the railway communication between Paris and Havre, which is the port of the capital, as far as its maritime trade with countries out of Europe is concerned, and where it will communicate directly with extensive docks now building. The terminus of the Rouen railway, at Paris, in common with that of the short lines from Paris to St. Germains, and to Versailles, by the right bank of the Seine, opened in 1837 and 1839 respectively. In 1840 another railway was completed to Versailles by the left bank of the Seine. Neither has proved very profitable; but it has been proposed for the two companies to amalgamate, and from a joint station at Versailles, to extend their lines to Chartres, Rennes, and Britanny.

Paris to Orleans.—Going westward, the next line we meet is that from Paris to Orleans, completed at the same time as that from Paris to Rouen, in 1843. The length of this line, including a branch to Corbeil, is 93 miles; the share capital 1,600,000*l.*, and the net returns about 10 per cent. It not only unites Paris with the flourishing city of Orleans, but also is extended thence in several directions; 1st, by the Orleans, Tours, and Bordeaux Railway, 300 miles long, now in progress throughout, and already opened from Orleans to Tours, a distance of 69 miles; 2nd, by the Tours and Nantes Railway, a branch from this to the principal centre of commerce on the west coast of France, 120 miles in length, the works of which are in a very forward state for about 65 miles, from Tours to Angers; 3rd, by the central railway from Orleans to Vierzon, Bourges, and Châteauroux. From Orleans to Bourges by Vierzon, a distance of 70 miles is completed, and may be opened for traffic as soon as a bridge over the Loire at Orleans is finished. As the construction of such a bridge will require a considerable time, a temporary bridge is about to be thrown over to connect the two railways in the interim.

Paris to the Mediterranean.—The next grand trunk line leaving Paris is that to the Mediterranean, the first section of which, from Paris to Lyons, will be about 300 miles in length. It is in progress throughout, but will not be completed until 1849 at the earliest. About 45 miles from Dijon to Chalons, situated half-way between the two extremities of the line, are nearly completed, and might be opened in the course of the present year. From Lyons there are railways already open to St. Etienne, Andredieux, and Roanne, remarkable as being the first lines of any length completed in France. The total length is about 90 miles, and these afford communication between the valleys of the Rhone and Loire, and pass through the Loire coal fields. The great line to the Mediterranean is continued from Lyons through Avignon to Marseilles; that part from Lyons to Avignon, 195 miles in length, including a branch to Grenoble, is not yet begun, although in the hands of a company; from Avignon to Marseilles, 65 miles in length, is nearly finished, and will probably be opened in the present year. A railway, which will branch from this at Tarascon, and runs to Nimes, Montpellier, and Cette, a rising port on the Mediterranean, with a branch to the mineral district about Alais, is finished, as also a small line in the neighbourhood of Bordeaux. A junction railway from Bordeaux to Cette through Toulouse has been proposed, and a company has been formed to construct it.

Paris to Strasburg.—A company has also taken the railway from Paris to Strasburg, the length of which, including branches to Rheims and to Metz and the Prussian frontier, is nearly three hundred and sixty miles. The works are in rapid progress, and a tunnel under the Vosges, 2,800 yards in length, completed. The greater part of the line will be finished in 1848, and the rest in 1849, with the exception of the section from St. Dizier to Nancy, which cannot be completed before 1850. A line from Strasburg to Bâle, the total length of which, including the branch from Mulhouse to Thaun, is 95 miles, was opened in the summer of 1841; it has not enjoyed much traffic, and cannot until extended from Strasburg to the more important towns on the lower part of the Rhine. In the district enclosed between the Paris and Lyons and Paris and Strasburg railways, one railway is in progress, viz., a branch from the former line to Troyes, and another is proposed from Dijon to Mulhouse, uniting the two. One from St. Dizier to Gray, the point where the Loâne becomes navigable, has also been spoken of.

The Northern Line from Paris.—The next line we arrive at, pursuing our course round the French territory, is the Northern line from Paris through Amiens and Arras to Douay, where the railway is continued in two directions, one branch proceeding through Lille to the Belgi an frontier, where it meets the Belgian state line from Ghent, and the other reaching the frontier *via* Valenciennes, whence it is continued by the Belgian government line to Brussels. The total length is 204 miles, and the railway was opened throughout on the 20th June last. Branches from Criel (on the main line) to St. Quentin, and from Lille to Dunkirk and Calais are in progress. This line is of great importance, as conuecting Paris with Belgium, Holland, and the North of Europe, and of still greater from the fact that 90 miles of it, as far as Amiens, form part of the approaching railway communication between London and Paris. The rest of the railway from Amiens to Boulogne, 75 miles in length, is in a very advanced state, and will be completed in less than a year. 28 miles from Amiens to Abbeville have been finished for some months past, and are expected to be opened for traffic in the course of next month. When this is accomplished the journey between London and Paris will be comfortably made in 17 hours; and in 12 hours when the railway is open to Boulogne. To complete our survey of French railways, we have only now to notice the branches from Rouen and Havre Railway to Dieppe and Fecamp, for the construction of which a company has been organised.

The hasty enumeration we have made of the various French railways completed, in progress, or undertaken by companies who have already obtained their acts, appear sufficient to justify the assertion, that when finished, they will not only furnish ready communication between Paris and the various centres of population and industry throughout the French territory, but also with the adjacent countries; and likewise afford great facilities on several lines of transit which already enjoy considerable traffic, both in passengers and goods, and some of which are indeed the high roads of Europe: such as those from London to Switzerland, the Mediterranean, or Spain, through Paris, from the United States to Switzerland, *via* Havre (a route taken by a large amount of goods-traffic), &c.

Little remains to be said in addition to this almost tabular view of the French system of railways; but it would be incomplete without a few remarks on the railway legislation of France. All the French railways, with one or two exceptions, are only conceded to the companies who have undertaken their construction, for a term of years, so that the companies have to provide for the reimbursement of the capital at the expiration of the lease by means of a sinking-fund, varying according to the length to which it extends. The railways from Paris to Rouen and to Orleans were conceded directly to the companies for terms of 99 years; and that from [illegible] Havre for 97; their agreements with the government having been afterwards submitted to the Chambers for ratification. After 1842 the government began to work on its own account on several of the great lines of rail-

* This interesting document lately appeared in the "Daily News."

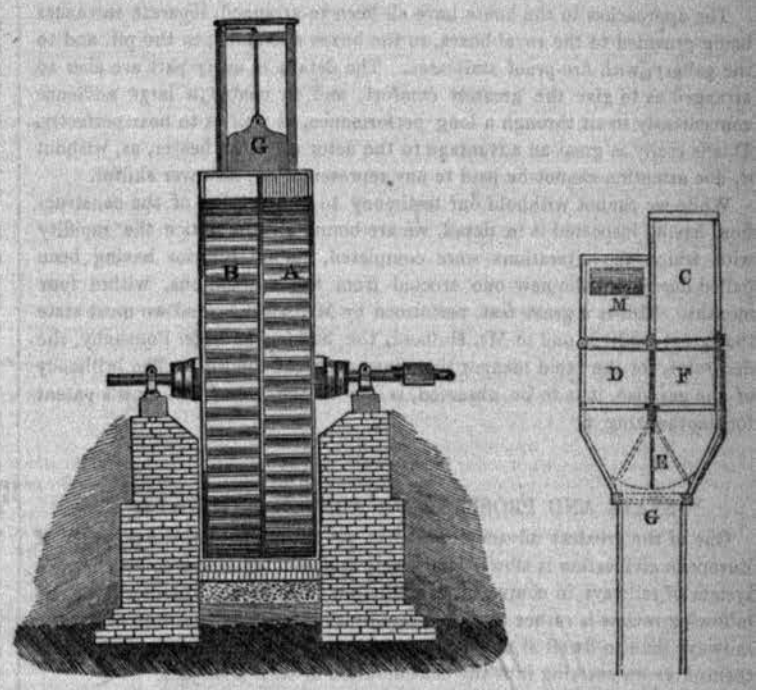
way, the exact directions to be taken by which were settled by the Chambers in that year; and since that period, the greater part of the new lines have been put up to auction, and conceded to the company offering the greatest reduction on a maximum term of concession fixed by the Chambers. For some, the government has been reimbursed by the companies for any outlay expended on the line conceded to them; for others, it continues to pay all the expenses of the earth work, leaving the company only to provide the rails and working stock—the length of lease of course varying, as one or other of these alternatives has been adopted. Among the lines in the latter position, are those from Orleans to Bordeaux, from Orleans to Vierzon, from Tours to Nantes, from Avignon to Marseilles, and from Paris to Strasburg; and in the former, are the Northern Railway, those from Boulogne to Amiens, from Paris to Lyons, and several other important undertakings. The length of the leases has varied much, according to the time at which the concession took place. The Boulogne and Amiens Railway, conceded in October 1844, before the excitement of 1845, was taken for 99 years, although of great value, as commanding the traffic between London and Paris; the Northern Railway, taken during the heat of that excitement, and the great advantages of which had been greatly exaggerated, has only a lease of 38 years; the Paris and Lyons, taken subsequently, has one of 41. The Lyons and Avignon is conceded for 45 years, the Bordeaux and Cette for 66. Among the lines, part of the outlay for which is borne by the government, that from Avignon to Marseilles has a lease of 33 years, during which it is calculated it will produce 10 per cent. per annum to the shareholders, while the less lucrative line from Orleans to Bourdeaux has only one of 28 years. The Paris and Strasburg Railway is conceded for 44 years, and that from Tours to Nantes for 34. By their acts, the various railway companies have a certain maximum tariff imposed upon them, under which they may make any alteration, but which they cannot exceed. These rates are 1·66d. per mile for a first-class passenger; 1·24d. for a second-class; and 0·91d. for a third-class passenger. For goods, the maximum rates allowed vary on each line, and are generally much higher than those actually charged on lines already at work. French railway legislation is confused, and, in many instances, faulty; while no one can now be blind to the evils of reckless competition, induced by the system of putting the leases of railways up to auction. On the other hand, the absence of parliamentary expenses, and the recognition of the principle that the first thing when a railway is to be made in any particular district is to get a decision from the Chambers respecting the exact route to be taken by it, so that no surveys need be undertaken by the company until this is determined upon, contrast favourably with the course of proceedure adopted in this country. On the whole, however, many of the strictures on the French system of railway legislation made by Mr. David Salomons in the lucid and interesting comparison between that system and the one pursued in this country, contained in his recent pamphlet, will be found to be correct. We have now entered into all the details it was our intention to touch at in the course of this brief investigation, but the whole subject will be probably rendered clear by a tabular view of the share capital of the various French railway companies, which we subjoin:—

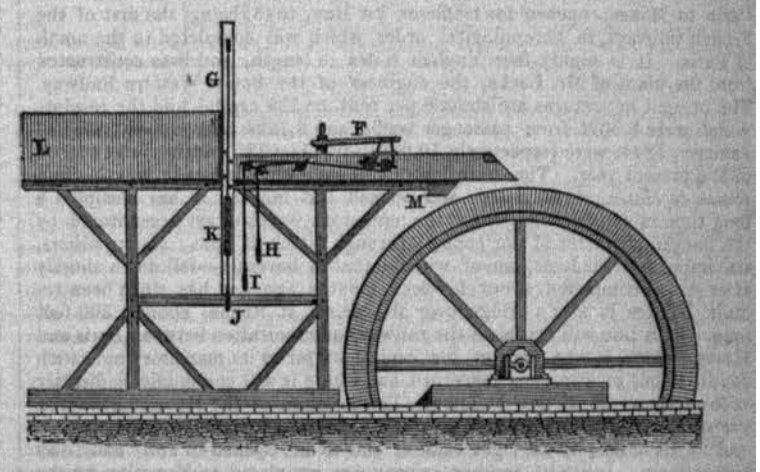
Name of line.	Paid-up capital.	Capital not called.	Total share capital.
Andrésieux and Roanne ..	..	..	..
Avignon and Marseilles ..	£ 800,000	..	£ 800,000
Bourdeaux and Cette ..	1,120,000	£4,480,000	5,600,000
——— Teste ..	200,000	..	200,000
Boulogne and Amiens ..	1,350,000	150,000	1,500,000
Central line	660,000	660,000	1,320,000
Dieppe and Fécamp ..	288,000	432,000	720,000
Grand, Combe ..	640,000	..	640,000
Lyons and Avignon ..	1,200,000	4,800,000	6,000,000
Montereau and Troyes ..	560,000	240,000	800,000
Montpellier and Cette ..	120,000	..	120,000
Mulhouse and Thann ..	104,000	..	104,000
Northern of France ..	3,200,000	4,800,000	8,000,000
Orleans and Bordeaux ..	780,000	1,820,000	2,600,000
Paris and Lyons ..	3,200,000	4,800,000	8,000,000
——— Orleans ..	1,600,000	..	1,600,000
——— Rouen ..	1,440,000	..	1,440,000
——— Sceaux ..	120,000	..	120,000
——— Strasburg ..	1,250,000	3,750,000	5,000,000
Tours and Nantes ..	400,000	1,200,000	1,600,000
St. Germain	360,000	..	360,000
Strasburg and Basle ..	1,176,000	504,000	1,680,000
Versailles (Right Bank) ..	440,000	..	440,000
——— (Left Bank) ..	400,000	..	400,000
Total ..	£21,408,000	£27,636,000	£49,044,000

Or a little more than 49,000,000*l.* Besides which, the several companies have raised by loan about 2,400,000*l.*

RICHARDSON'S REVERSING WATER-WHEEL.

This wheel is designed for the purpose of raising slate from the Coombe Valley Quarry, and is proposed to do the work of a steam engine, without its attendant expenses—the chief object being to throw all its available power into direct action, without the intervention of gear-work. Its projector, Mr. Richardson, says, that to cause rotary machinery to reverse, it is usual to introduce bevelled gear—all gear-work creates friction—friction loss of power, waste of time, and money. To save time is the great desideratum in conducting the works of a public company; for if this important point is neglected, the profits expected to be derived can never be realised.





The following description will explain the method of its working:—A and B represent a front elevation of the wheel; the buckets on the side A, are placed in an inverse direction to those on the side B; C, is an over-shot launder, or water-course, flowing on to B; D, a backshot launder, conducting the water on to A, which acts in a reverse manner to that of B; E, a reversing gate, hung on a centre, and having a hollow quoin, similar to a common navigation lock-gate. F, a lever, attached to the axle of the gate, E, which, with its connecting pulleys, H and I, is made to turn the water alternately off and on to the overshot and backshot launders, C, and D; G, the stopgate. H, the overshot pulley; I, the backshot pulley. J, the stopgate pulley, having a graduating plate, K, attached for the purpose of regulating the feed. L, feed-head, or reservoir. M, the water way of backshot launder, D: when the wheel is set in motion, the lever F, is

pulled over, and the gate G, raised; the water then flows on to the overshot section B. On the signal being given to stop, the gate G, is shut down; and the water in the launder C, is just sufficient to drive the wheel half a revolution, when it stops for want of its propelling power. On the signal being given to start in a reverse direction, the lever F, is pulled over; and on the gate G, being raised, the water flows on to the backshot section A, and thus alternately. Thus, nearly the whole of the gravitating force of the water is applied in a direct manner, and must save, independent of the cost of construction, and liability of breakage in gear-work, a great amount of power, which, where water is scarce, is a considerable advantage.—*Mining Journal.*

REGISTER OF NEW PATENTS.

GAS IMPROVEMENTS.

GEORGE LOWE, of Finsbury Circus, civil engineer, for "*Improvements in the manufacture of, and in burning gas, and in the manufacture of fuel.*" Granted October 8, 1846; Enrolled April 8, 1847.—(Reported in the *Patent Journal.*)

This invention relates firstly, to preparing peat in combination with resin, pitch, oil, fat, or other hydro-carbonaceous matter, and making gas therefrom; secondly, to a mode of arranging apparatus for purifying gas; thirdly, to improvements in making gas from coal and other matters rich in carbon, by introducing steam highly heated into the retorts used for that purpose; fourthly, to improvements in Argand gas-burners, whereby the gallery or apparatus for supporting the chimney is made to rise on a screw, so as to adjust the admission of the air to the flame; and fifthly, to certain means of manufacturing fuel from peat by causing dry blocks of peat to be saturated with pitch or other hydro-carbonaceous matter: the peat being prepared and dried, is piled in a square iron vessel, about eighteen inches deep, till within two or three inches of the top; a quantity of resin, tar, or other hydro-carbonaceous matter, highly heated, is run into the vessel till the peat is entirely covered; heat is also applied to the bottom of this vessel, in which the peat is kept for about an hour, in order to induce the hydro-carbonaceous matter to enter the peat; it is then run off, and the cakes of peat thus saturated are placed on shelves or racks, and allowed to drain the unabsorbed matter from the surface thereof. A method which the patentee considers preferable to the foregoing is, instead of placing the dry peat in an open vessel, he introduces it into a close vessel, similar to that used in the well-known method of treating wood in which he forms a vacuum by steam or otherwise, and then allows the heated matter to run in, and afterwards forcing it in with considerable pressure; the peat is permitted to remain in this state for about half an hour, when it may be withdrawn, the unabsorbed matter being drained from the surface as before. Where tar is used the patentee prefers mixing with it about from five to ten per cent. of quicklime in a state of powder.

The second part relates to an apparatus for purifying gas, and which consists of two chambers placed one above the other, filled with coke, through which the gas passes, in a similar manner to that which is known as the scrubber: the chambers containing the coke are divided by a space containing an apparatus for distributing a weak ammoniacal liquor on the coke contained in the lower chamber; this apparatus, which forms the novelty of the invention, consists of two or more arms, placed on an axis, on which it revolves horizontally, each arm being perforated with a number of holes on one side, at different distances from the centre or axis; the holes in one arm being on a different side to that of the other, any liquid being allowed to pass into it causes it to rotate, and thereby distribute the liquor over the coke. The principle of this will at once be recognised to be the same as Barker's mill, and will be readily understood. The upper chamber is furnished with a similar apparatus, which supplies it with water, or water slightly acidulated with muriatic or sulphuric acids, in a similar manner to the other; the weak ammoniacal water, or acidulated water, are contained in reservoirs above the chambers, the fall propelling this apparatus as before described. The coke in the upper and lower chambers is sustained on gratings, allowing the gas to pass freely through, which enters from the condenser by a pipe at the bottom, and passing through the chambers of coke, escapes from the upper chamber, partially freed from ammonia. This operation may either be conducted before or after the usual process of purifying gas, but he prefers that it should take place after that process.

The third improvement, for the method of introducing highly-heated steam to retorts during the production of gas or other matters, rich in carbon, is as follows:—Steam being generated in a suitable boiler, is allowed to flow freely into the retort, at a point furthest distant from that at which the gas escapes; the steam in its passage from the generator to the retort is passed through pipes, heated to a great degree, in a similar manner to that employed for obtaining the hot blast, used for smelting iron and other purposes; it is well known that this method of heating steam does not materially interfere with the pressure at which it may be generated, and which should not be greater than that at which the gas is produced, as it would cause too great a flow into the retort, neither should it be allowed to flow during the whole time of one charge, and, therefore, the pipes must be furnished with suitable stop-cocks, and each retort furnished with a gas-burner, so as to enable the workmen to judge when the jet of steam should be discontinued, which will be when the gas begins to lose colour, the regulation being easily acquired by a little experience.

The fourth improvement consists in constructing the gallery which carries the chimney, so that it shall be adjustable, in order to regulate from time to time the height of the point at which the air supplied for combustion shall be made to impinge on the exterior of the flame: the method shown in the drawings attached to the specification, is by cutting a screw on the inside ring of the gallery, and on the outside of the burners; it will, therefore be apparent that on turning the gallery round it will either raise or lower it, and at the same time the contracted part of which for deflecting the air will either be brought nearer to or farther from the jet of the burner, according to that which may be considered the best position, and will be regulated in some measure by the extent of flame required; when the air is deflected by a cone inside the chimney, it is attached to the gallery and moves up and down with it; other means besides the screw may be employed for raising and lowering the gallery, and thereby regulating the admission of air as before explained.

Fifth and lastly, this invention relates to the treating of dry peat and hydro-carbonaceous matter for fuel, in the same way as that described under the first head of this specification. Having described the nature of his invention, and that which he considers the best means of carrying the same into effect, he wishes it to be understood that he does not confine himself to the precise details herein described, so long as the principle of either part of his invention be retained; but what he claims is—first, the mode of treating blocks of dried peat for the manufacture of gas by placing them in an open vessel and immersing them in highly-heated resin, pitch, oil, fat, or other hydro-carbonaceous matter, and also the saturating blocks of dry peat, by placing them in closed vessels. Second, the application of revolving perforated pipes to distribute the purifying liquor in apparatus, such as before described. Third, the application of highly-heated steam introduced into retorts when making gas from coal or other matters. Fourth, adjusting the admission of air to the outer flame of Argand burners by means of a screw or otherwise. Fifth and lastly, the saturating blocks of dry peat, for the purposes of fuel, with resin, pitch, oil, fat, or other hydro-carbonaceous matter, by means of an open vessel and heat, and also by means of a closed vessel, as hereinbefore described.

GUN COTTON.

JOHN TAYLOR, of the Adelphi, gentleman, for "*Improvements in the manufacture of explosive compounds.*"—Granted October 8, 1846; Enrolled April 8, 1847. (A communication.)

This improvement relates to manufacturing an explosive substance, by the application of nitric acid or nitric and sulphuric acids to vegetable matters. The specification describes the converting of cotton into an explosive substance, as the patentee considers cotton the most available substance.

In preparing cotton, take nitric acid of sp. gr. from 1·45 to 1·50, and sulphuric acid of sp. gr. 1·85, and mix the acids in the proportions of three parts sulphuric acid, and one part nitric acid; they are then allowed to cool down to between 50° and 60° Fah. and then rough cotton, previously freed from all extraneous matters, is to be immersed in the mixed acids, in a suitable vessel of glazed earthenware, in as open a state as possible, occassionally stirring it with a glass rod; the excess of acid is to be drawn or poured off, and the cotton pressed with an earthen presser, lightly, so as to separate the principal part of the acid. The cotton is then covered and allowed to remain for one hour; it is then pressed, and thoroughly washed in running water, to divest it from all free acid until it does not in the least affect litmus-paper: afterwards it is to be partially dried by pressure, and to insure its freedom from free acid, it is to be washed in a dilute solution of carbonate of potass, made by dissolving one ounce of carbonate of potass in a gallon of water, and put under a press, and the excess of carbonate of potass solution pressed out, which at the same time renders the cotton nearly dry. It is then washed in a solution consisting of one ounce of pure nitrate of potass in a gallon of water, pressed and dried in a stove or room heated by steam or hot water to the temperature of from 150° to 170° Fah. The nitrate of potass seems to increase the explosive force of the cotton, but it is not absolutely necessary. In using cotton prepared as above, it must be borne in mind that to produce the same effect, much less must be used than of gunpowder, that is, in about the proportion of three parts of the prepared cotton to eight parts of Tower proof gunpowder.

Explosive cotton may be prepared by using nitric acid only, but the patentee prefers using the above mixture of nitric and sulphuric acids. In using cotton prepared as above for the purpose of propulsion, as it is of a fibrous nature, it may be rammed at once into the gun, or if made slightly moist and pressed into a mould, it will, when dry, retain its form, and thus may be made into cartridges.

The patentee does not confine himself to the specific gravity of the acids above mentioned, neither to the exact process herein described, but what he claims is, the converting vegetable matters into explosive substance by means of nitric acid.

FILTERING APPARATUS FOR STEAM ENGINES.

Nicholas Harvey, of the Hayle Foundry, Cornwall, engineer, for "*Improvements in filtering of water for steam engines and boilers.*"—Granted September 3, 1846; Enrolled March 3, 1847.

These improvements relate to the introduction of a filterer in connection with steam engines and boilers, for the purpose of preventing incrustation, by packing in a vessel *a*, compressed sponge *b*, or other filtering medium, between two perforated plates *c*, as shown in the annexed figures. The supply of water is forced through the sponge by the action of force pumps, and during the passage of the water, the mud or sediment is deposited in the vessel *f*, from which it is occasionally removed.

Fig. 1, is a vertical section of the apparatus, *a* is a cylindrical case, *b* the sponge or filtering medium compressed between two perforated plates *c*, the pressure on the top plate being regulated by the weights *d*; the sediment is deposited on the funnel-shaped diaphragm *e*, and then passes through the aperture in the bottom into the vessel *f*; at the top of the vessel is a funnel *g*, with a cock for the purpose of introducing water to cleanse the sponge or filtering medium; *h* is the feed pipe for supplying the filterer with water, and *i* the feed pipe to the boiler; *j* is a pipe for drawing off the sediment from the vessel *f*.

Fig. 2, shows the apparatus connected with the hot well, and is similar in principle to fig. 1.

Fig. 1.

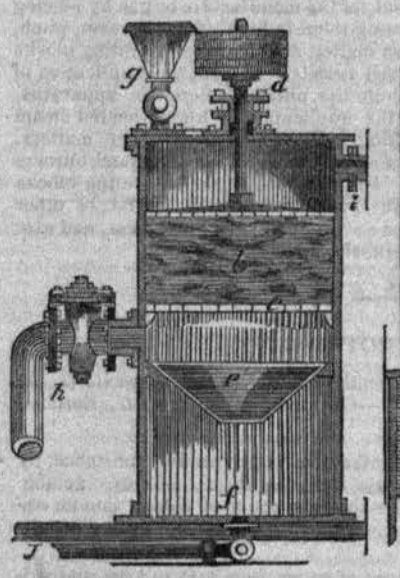
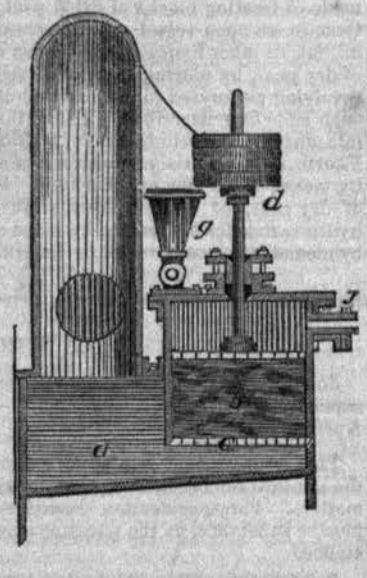


Fig. 2.



FLATTENING GLASS KILNS.

Henry Deacon, engineer, of Eccleston, Lancashire, for "*Improvements in the construction of flattening kilns.*"—Granted September 26, 1846; Enrolled March 26, 1847.

These improvements relate first to the introduction of a moveable bridge, or partition to close the aperture between the flattening kiln and the piling kiln, used in the manufacturing of glass, and in the application and arrangement of wheels and rails to the floors of the kilns, and to the flattening stone. The bridge is similar to those generally adopted by iron masters, engineers, and smiths, for furnace doors, by constructing a frame of wrought or cast iron, to cover the opening between the kilns; this is filled full of fire-bricks, and suspended from the end of a rod passing through the roof of the kiln, and attached to the end of a chain, which after passing over pulleys, has a counter-balance weight attached to it, in a position for the workmen to open or close the communication between the kilns.

The patentee states that this moveable bridge is very useful in bending glass for tiles, or for roofs of conservatories, &c. The mode of manufacture is as follows: having placed the mould on which the glass is to be bent on the flattening stone, the glass is inserted through the push hole, where, after it is properly heated, it becomes the shape of the mould; the communication between the kilns is opened by raising the bridge or partition, and the mould is pushed back into the piling kiln, where it is removed from the mould by suitable instruments used for that purpose, and may be piled there, either on its edge or on its side; the bridge is then closed, and the operation of preparing another article is commenced as before.

The second improvement relates to building in the floor of the spreading and piling kilns, and furnishing the spreading stone with suitable rails, to run thereon. The wheels employed for this purpose are of cast iron, about 17 inches diameter, by an inch broad in the rim; they are built in the floors of the kilns in two rows, each row about two thirds the breadth of the spreading stone from the other, and the wheels from centre to centre, at a distance in proportion to the length of the stone; the floor is built close up to the sides of the wheels, till nearly on a level with the periphery; any dust or broken glass falling down into a chamber below, from whence it may be drawn by suitable instruments. The rails on which the spreading stone is supported is straight along the lower edge, or that which comes in contact with the wheels; the upper edge has several raised clipping pieces which are reduced until the stone is fairly bedded thereon; and furnished with lugs at either end to embrace the stone and keep it in a proper position with the rails. One of the rails is furnished with a groove in the direction of its length rather wider than the periphery of the wheels, which guides the carriage as it traverses backwards and forwards on the circumference of the wheels, from the spreading or flatting kilns, to the annealing or piling kilns.

TUBULAR BRIDGES.

William Fairbairn, of Manchester, civil engineer, for "*Improvements in the construction of iron beams for the erection of bridges and other structures.*"—Granted October 8, 1846; Enrolled April 8, 1847.

Fig. 1.

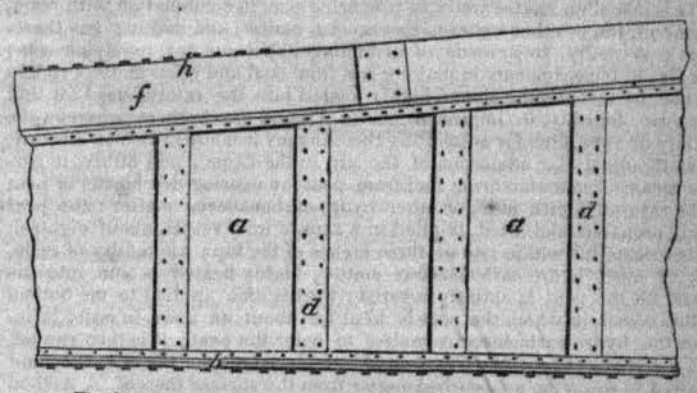
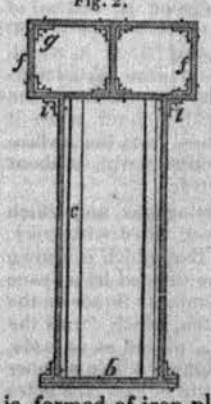


Fig. 2.



These improvements relate to the construction of iron beams or girders, for bridges and other structures, by the use of plates of metal united by rivets and angle iron. Fig. 1, is a side elevation of part of a hollow iron beam, or girder; and fig. 2, a transverse section,—*a*, side plates; *b*, bottom plates; *c*, *c*, interior vertical angle or T iron for connecting the plates, *a*, *a*, with the covering plates, or styles, *d*, and rivets. The side plates are to be put together with butt joints, and rivetted in a similar manner to boiler making. The top of this hollow beam is formed of two or more rectangular cells, composed of plates *f*, and angle iron *g*, fastened by rivets, and attached to the side plates *a*, by the angle iron *i*. The bottom of the hollow beam or girder is formed of iron plates *b*, fastened by means of covering plates over the cross joints, and rivets attached to the side plates by angle iron. The top of the hollow beam, or girder, may be constructed of cast or malleable iron, either cellular rectangular, as shown in fig. 2, or of an elliptical or any other suitable form, to prevent the top giving way, or puckering from compression; or other methods may be employed, such as thick metallic casting, or lighter iron plates, arranged so as to form hollow cells. The bottom of the hollow beam or girder may be also constructed of a series of plates, *b*, either of single or double thickness, rivetted together; the plates are united to each other by alternating or breaking joint, and by a peculiar mode of riveting, called by the inventor chain-riveting, as it forms an entire chain of plates throughout; and the structure so unites the covering plates over the joints as not to weaken or otherwise injure the plates by rows of transverse rivet holes, but to form a connecting link to each joint, by a series of longitudinal rivets or pins. The drawings attached to the specification show various forms of girders to render them applicable to factories, warehouses, dwelling-houses, &c.

IMPROVED WATER CLOSETS.

JOSEPH BUNNETT, of Deptford, Kent, engineer, for "*Improvements in water closets, part of which improvements is applicable to other useful purposes.*" Granted April 15; Enrolled Oct. 15, 1846.

Fig. 1

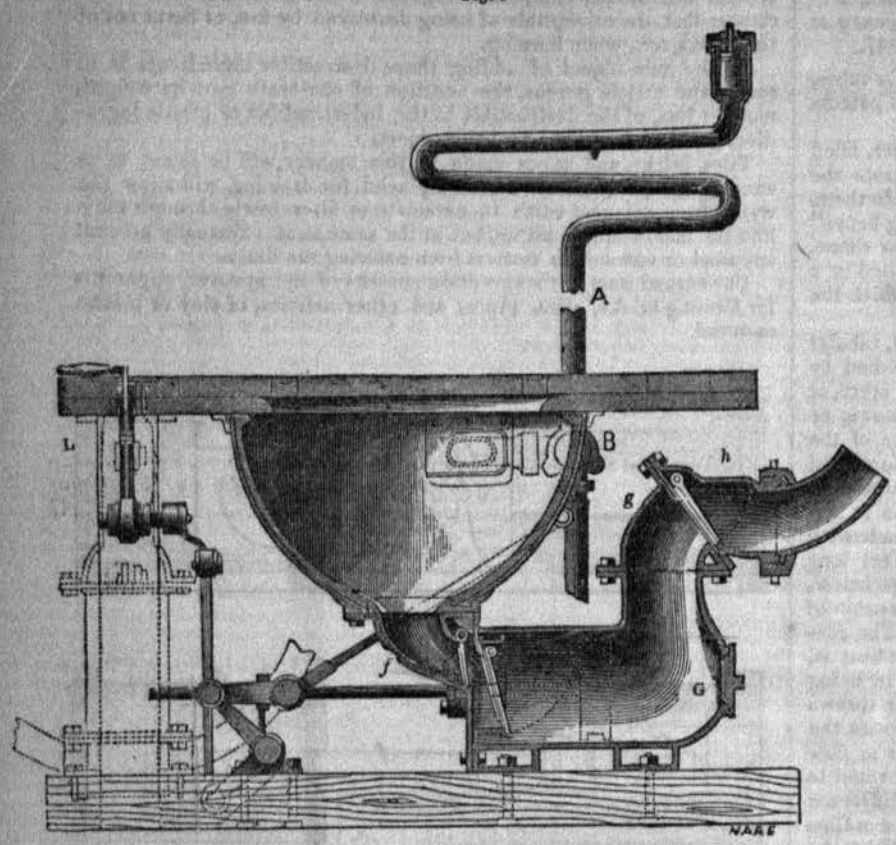


Fig. 2.

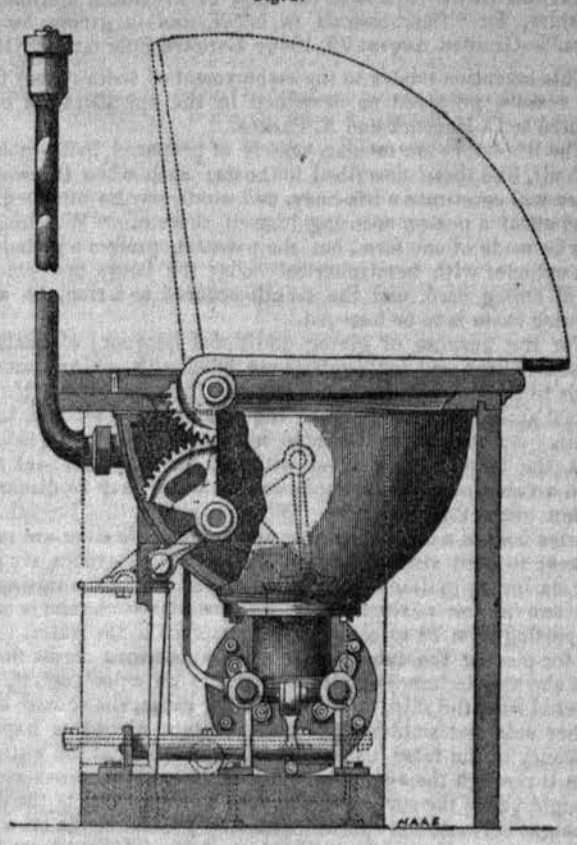
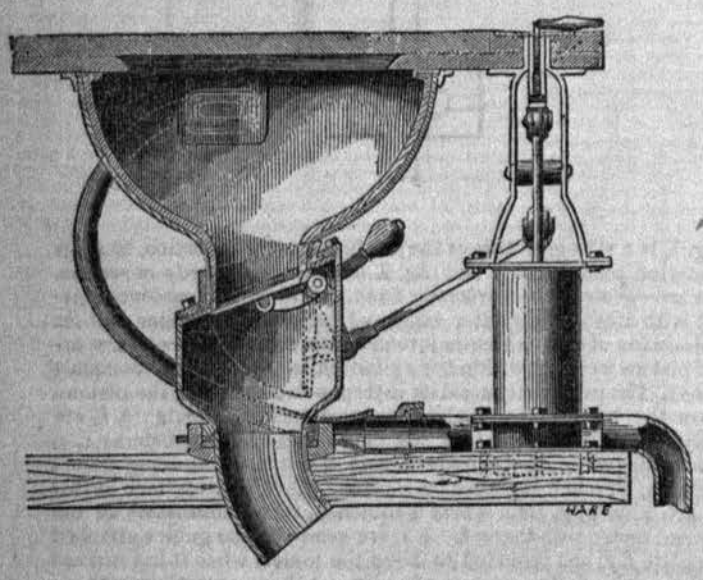


Fig. 3.



This invention relates to an improved form of water closet, for shipping, and which is also applicable for dwelling-houses, where the sewer or outlet may be *above* the water closet. Fig. 1 is a section, and fig. 2 a side view, of a water closet with the improvements. The basin is supported upon a flanged elbow piece *f*, and bolted to a horizontal pump or piston barrel G, terminating in a delivery piece *g*. Within the elbow piece *f*, there is a valve, opening towards the piston barrel, which valve is fitted and dropped into its place upon a seating, as shown in the drawing, previously to the basin being fixed. Within the piston barrel G, there is a piston, furnished with a valve, opening towards the delivery end of the barrel; this piston is worked by two horizontal piston-rods, passing through stuffing-boxes,—only one is seen in fig. 1, but the ends of both are shown in fig. 2. On the upper part of the delivery piece *g*, there is a valve, opening outwards towards the second delivery piece *h*, upon which an union screw is cut, for the attachment of a soil pipe, which may be taken to the most convenient point (either above or below the water-line), for delivering the matters ejected by the piston. L is the handle, working through a slot in the seat of the closet, by which the action of the closet is effected, through levers and connecting rods, working the horizontal piston-rods, and also for giving motion to a rod which opens and closes the cock B; this cock communicates with the water on the outside of the ship by a pipe on its under side, and with a reservoir or cistern pipe (A) above, and also with the basin of the closet. On raising the handle L, motion is given to the cranked levers, which causes the piston with the valve to traverse in the barrel G, as shown by the dotted lines (fig. 1), and expel whatever substances have passed through the valve. The motion of the levers will at the same time open a communication with the pipe A, the contents of which will rush down into the basin. On pressing down the lever, the piston will retrogade in the barrel G, and whatever substances have passed the valve *f*, will be forced through the valve in the piston, into the piston barrel, and be ejected by the next motion of the piston. The connection with the external water will, by the same movement, have been opened, and the pipe A will become filled, ready for rinsing the basin on the next movement of the pump. In order that the pipe A, may perform the office of an elevated reservoir or cistern, it should be from two to three feet higher than the top of the basin; it is fitted with a floating air-valve at its upper end, which is closed by the rising of the water when the pipe is filled, but opens and admits air when the pipe is discharging its contents into the basin. The pipe must be of such capacity as to hold the quantity of water required for the use of the basin. The patentee prefers a small pipe (say ¾ inch diameter), and leads it in a convoluted or zig-zag form, as shown in the engraving, so as to maintain a head of water as long as possible, to give the necessary force to the jet passing through the fan. If the watercloset is to be fixed in a ship, so that its seat will at any time be less than two feet below the level of the external water, the water will not rise high enough in the pipe A, to acquire sufficient force by its gravity to cleanse the basin. In such cases the supply of water is to be drawn by means of a small force-pump or pumps worked by the lever, as shown in fig. 3; these pumps drive the water through a pipe carried up one foot or more higher than the level of the external water line, so as to guard against any undue influx of water through the pump valves.

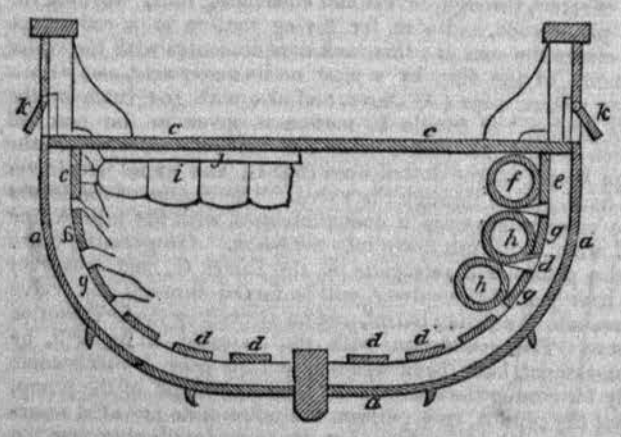
LIFE BUOYS AND BOATS.

ARTHUR HOWE HOLDSWORTH, Esq., of Brookhill, Dartmouth, Devonshire, for "*Improvements in buoys, and in giving buoyancy to boats.*"—Granted August 29, 1846; Enrolled February 29, 1847.

This invention relates to the employment of india-rubber for tubes, and vessels, prepared as described in the specifications of patents granted to C. Hancock and A. Parkes.

The life-buoys are tubular vessels of prepared india-rubber, filled with air, like those described for boats; each when thrown into the water will constitute a life-buoy, and cords may be attached to them, to admit of a person securing himself thereto. "Watching buoys" may be made of any form, but the patentee prefers a globular shape, or a cylinder with hemispherical ends; the buoys are enclosed in a net of strong cord, and the mouth secured to a ring, to which the mooring chain is to be fastened.

For the purpose of giving additional buoyancy to boats, tubular vessels of prepared india-rubber are filled with air, and attached by cords to the raisings under the thwarts, from the head to the stern, or placed across the boat, beneath the thwarts, and secured thereto by cords. Apertures five by three inches are made in the sides of the boat (the bottom being level with the thwarts), and each furnished with a valve, opening outwards, so that water may be discharged but cannot enter through them. When applying this invention to the quarter boat of a large ship, four apertures in the sides are made with valves; to each side of the boat are attached six tubes, six feet long and six inches in diameter, four being secured to the raisings below, and two to the raisings above the thwarts: each tube is capable of supporting from 74 to 80 lb. when immersed in the water. The reason for placing the tubes at the side, rather than across the boat is, that she may be more readily restored to an even keel, if, in being lowered from the ship, or from any other cause, she should be thrown on her side and suddenly filled with water; when this happens, the buoyancy of the tubes causes the boat to rise and the water to flow from it through the apertures, until the gunwale becomes elevated to a height above the surface of the sea, corresponding to the difference in height between the apertures and the gunwale—the crew can then easily throw out the remainder of the water. Boats intended to be used solely as life-boats, have six or eight apertures in their sides, and in addition to the ordinary raisings under the thwarts, one or two more are fixed below them, and to these additional tubes are secured.



The annexed figure is a transverse section of a boat, constructed according to this invention. *a*, *a*, are the side and bottom planks; *b*, *b*, the ribs; *c*, *c*, the thwarts; *d*, *d*, the internal bottom boards; *e*, *e*, the raisings or rails under the thwarts; *f*, one of the tubular vessels attached thereto; *g*, *g*, the additional rails; and *h*, *h*, the corresponding tubular vessels. *i*, is a tube connected to the under side of the thwart by cords, for which purpose the rails *j*, are applied; *k*, *k*, are the valves or doors for closing the apertures in the sides of the boat; they turn on a hinge at the upper part, and are furnished with weights to cause them to close readily, and be kept closed, when required, by means of cords.

BRICK MACHINE.

FREDERICK RANSOME, of Ispwich, engineer, and JOHN CRABB BLAIR WARREN, of Little Horksley, Essex, clerk, for "*Improvements in the manufacture of bricks, tiles, pipes, and other articles composed of plastic materials, and in the preparation of plastic materials to be used for such purposes.*"—Granted July 6, 1846; Enrolled January 6, 1847.

The first part of the invention consists in mixing in the pug-mill, with the clay or plastic materials, of which bricks, tiles, and similar articles are usually composed, vegetable, bituminous, or other substances that are susceptible of being destroyed by fire, or burnt out of the bricks, &c., when burning.

As the sole object of adding these destructible ingredients is to render the article porous, the addition of one-tenth part by weight, more or less, of the destructible to the indestructible or plastic ingredients. will be found to effect this object.

Tiles, bricks, and pipes made in this manner will be found to be exceedingly porous, and, when employed for draining, will allow the water from adjacent earth to percolate or filter freely through them into the hollow space within, but at the same time effectually prevent any sand or extraneous matters from entering the drain.

The second part of the invention consists of an improved apparatus for forming bricks, tiles, pipes, and other articles, of clay or plastic material.

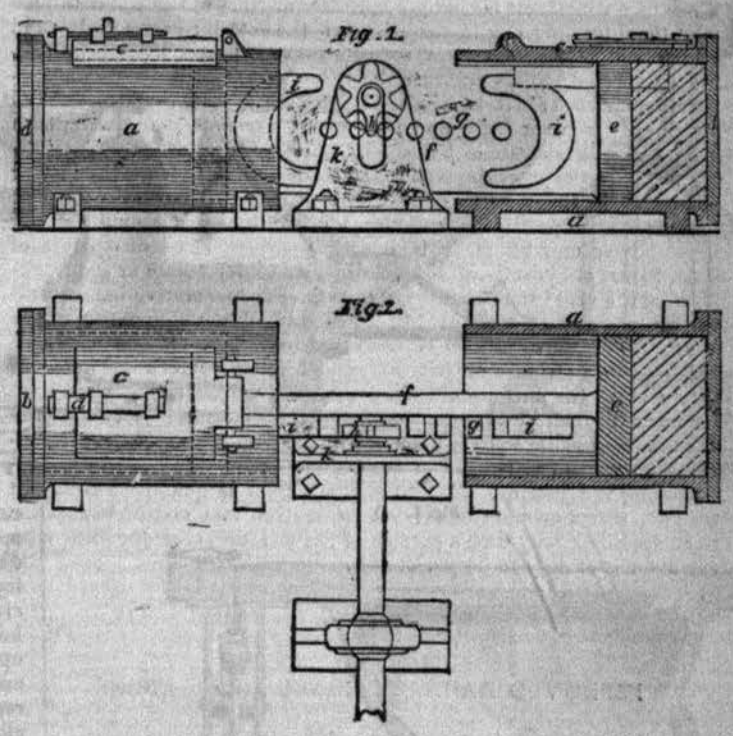


Fig. 1, is a side elevation of the machine, partly in section, to show the interior construction; and fig. 2, is a plan, also partly in section. In this arrangement two horizontal fixed cylinders are employed, furnished with dies at their outer ends, and doors on the upper part for the admission of clay, which is forced out through the dies by the action of pistons working within the cylinders, in the manner commonly practised. The peculiarity consists in the mode of working the pistons. *a*, *a*, are the horizontal cylinders, secured to a bed-plate; *b*, *b*, are suitably-formed dies, bolted to the outer ends of the cylinders; *c*, *c*, are doors hinged to the cylinders with a bolt *d*, for securing them; *e*, *e*, pistons, attached together by a plate *f*, *f*. Upon one face of this plate are pins *g*, *g*, into which a pinion *h*, takes alternately on the upper and under side thereof. *i*, *i*, are semi-circular guides attached to the plate *f*, *f*, and intended to keep the pinion, when it has arrived at either end of the series of pins, still in gear therewith, in order that the traverse of the pistons may be continuous. The pinion *h*, is mounted in a slotted bearing *k*, and its axle may be provided with a winch-handle, for communicating a rotating motion to the pinion. The cylinders *a*, are filled alternately with clay by the door *c*. When the cylinder is filled, the door is closed, and the rotation of the pinion *h*, will then bring forward the piston, and cause the clay to find an exit through the die *b*. While this is being effected, the other cylinder is ready to be charged with clay, which in its turn will be forced out by the return motion of the pistons. It will now be understood that the continuous rotation of the pinion *h*, in one and the same direction, will force the pistons alternately forward in their respective cylinders, and cause them to press the clay contained therein through the dies attached to the ends of the cylinders. In some cases, instead of filling the cylinders by hand, as is the plan generally adopted, the patentees propose to attach a hopper to each cylinder, whereby the clay may be fed in by the rotation of "sweepers" or arms, set

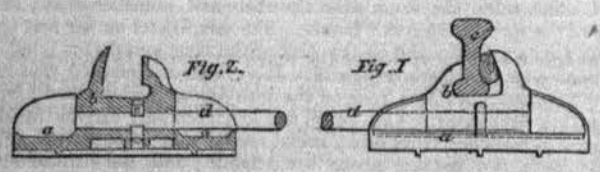
radially from the central shaft, and at an inclination from the perpendicular. When these hoppers are used, it will be necessary to stop the supply of clay as the pistons advance to press it through the dies: this may be done by a sliding-plate, or a valve, opening inwards, being made to close the bottom of the hopper; or the pistons may be provided with a shield to shut out the further supply of clay as they advance. In either case it will be requisite to stop the rotation of the sweepers or arms of the pug-mill.

INCRUSTATION OF BOILERS.

MAXIMILIAN FRANCOIS JOSEPH DELFOSSE, of Regent-street, Middlesex, for "*Improvements in preventing and removing incrustation in steam-boilers.*"—Granted August 25, 1846; Enrolled February 25, 1847.

This invention consists in adding to the water used in steam-boilers a mixture which acts on the precipitable matters in the water to prevent them forming any incrustations on the interior of the boiler, and which will also remove any incrustations that may have been previously formed. This mixture the patentee has named the "antipetrifying mixture;" it is composed of dry tannic or gallic extract, hydrate of soda, or soda deprived of its carbonic acid, muriate of soda, and subcarbonate of potash. The proportions will vary according to the impurity of the water, and to the boiler being stationary or locomotive. If the boiler be stationary, and fed with fresh water, the amount of antipetrifying mixture for 336 hours consumption per horse-power may be made by mixing together 12 oz. of muriate of soda, 2½ oz. of hydrate of soda, 2 drachms of dry tannic or gallic extract, and ½ oz. of subcarbonate of potash. For locomotive boilers, travelling on an average about 140 miles each day, the quantity of the mixture per horse-power is increased one-fifth. If the water be brackish, or a mixture of salt water and fresh (such as the water of tidal rivers), the muriate of soda is omitted, and instead 6 oz. are used for 2½ oz. of hydrate of soda, and five drachms instead of two of the dry tannic or gallic extract; the mixture is also prepared in this manner when sea-water is used in the boiler. The patentee prefers introducing the mixture into stationary boilers in quantities sufficient for two, three, or more days; but locomotive and marine boilers are to be supplied daily with a portion of the mixture, corresponding with the amount of duty to be performed.

IMPROVED RAILWAY CHAIR AND SLEEPER.



M. M. Bessas-Lamégie and Henry, of France, propose to combine the ordinary railway chair and the sleeper, by forming them of cast-iron in one casting, as shown in the annexed figure; *a* is a cast-iron plate, and *b b* the chairs, which are kept at the proper gauge by an inch round wrought-iron bar *d* passing through the chair, and secured thereto by vertical pins *e*; the underside of the plates are grooved or ribbed to prevent them slipping.

HISTORY OF ENGINEERING.

BY SIR J. RENNIE, PRESIDENT OF THE INSTITUTION OF CIVIL ENGINEERS.

(*Concluded from page* 119.)

IRON VESSELS.

The very important improvement in the introduction of iron for the construction of vessels, enables us to combine lightness and elegance of form with strength and durability. For this valuable addition to marine architecture we are indebted to Aaron Manby. In 1820-21 he constructed at Horseley, near Birmingham, a wrought-iron boat, called the 'Aaron Manby,' 120 feet long and 18 feet beam, and when laden drawing 3 feet 6 inches water; it was propelled by Oldham's feathering paddle-wheels, worked by a single engine of 80 h.p.; and was built for the purpose of plying on the river Seine. The boat was completed in 1821-22, and was navigated across the Channel by the present Sir Charles Napier, who was deeply interested in the undertaking; it was not only the first iron vessel that ever made a sea voyage, but also the first that conveyed a cargo from London to Paris direct, without transhipment. She continued plying between Paris and Havre for several years, until superseded by other more powerful and improved boats: the hull is yet in existence, and is still used with new engines on board, as are three others, which were built about the same time. In 1832 Maudslay and Field built four iron vessels for the East India Company, for the navigation of the Ganges, and fitted them with oscillating engines, of the united power of 60 horses; they were 120 feet long, 24 feet beam, and drew 2 feet water; they were so successful that six more were ordered shortly afterwards. The use of iron, however, did not make much progress until recently, on account of the prejudices and obstacles which generally, if not invariably, impede the progress of all great inventions. At present, iron is much employed for vessels, and promises in many cases to supersede timber. Objections against its general employment have been urged, on account of the bottoms of the vessels being liable to become foul on long voyages, and for the purposes of war, the splinters of the iron when struck by shot are said from recent experiments to be more detrimental than from wood. The art of building iron vessels is, however, in its infancy, and it is very probable that further experience and investigation will, in a great measure, obviate the evils. The strength, lightness, and other qualities that have been mentioned, give it great advantages for the construction of fast-sailing passage-vessels, and the water-tight bulkheads constructed with it, give great additional security in case of accidents; these water-tight bulkheads are now almost universally adopted; but the precise date and origin of their introduction is not very clear. Captain Evans, of Holyhead, proposed them for timber vessels in the year 1826, and soon after that time they were used in an iron vessel constructed by Grantham for C. W. Williams. Examples of their importance have frequently occurred, demonstrating the necessity of their introduction into all vessels, whether for river or sea navigation.

SCREW PROPELLING.

Great as has been the result of steam navigation under the paddle-wheel system, still as perfection is approaching, it cannot be denied, that it has several disadvantages when applied to sea navigation during stormy weather, which it is most desirable to obviate. Paddle-wheels act to the greatest advantage in smooth water and upon an even keel. The unequal immersion of the paddle-wheels during the rolling of the vessel, in a heavy sea, prevents that uniformity in the action of the engines, which is necessary to insure their greatest effect, and although this may be lessened, to a certain degree, by the use of mechanical or feathering wheels, as I have already stated, the complexity of their construction is objectionable. The resistance, offered by the paddle-boxes to the wind, in addition to their top weight, has a sensible influence in diminishing the speed and effect of the engines, and in ships of war, the great space occupied by the wheels on the broadsides of the vessels, materially interferes with the efficiency of the batteries; moreover, the wheel, as the principal propelling agent, being constantly exposed to shot, is under very considerable risk of having its efficiency impaired. The idea, therefore, of substituting for it some other propelling agent, had long been a favourite object of investigation amongst engineers. The origin of this, like every other great invention, is very difficult to be ascertained with accuracy, as the same idea not unfrequently occurs at the same time to different individuals, totally unconnected with each other. The first idea of stern-propelling was very probably suggested by the movement of fishes, whose chief propelling power exists in the tail, as also from the common and ancient practice of sculling a boat from the stern. A rude idea of stern-propelling is attributed to Duguet in 1727, but it was so totally different from the system now employed, that it can scarcely be called the same invention. His system consisted of two boats, connected together by two cross beams with a screw, inserted between the boats; this double boat was moored to a post in the river, and the current, acting upon the screw, turned it round, the motion thus generated, was communicated over pulleys, to which were attached the vessels to be drawn along; this plan may be likened to the effect of a water-wheel, or any other fixed first mover; still there is an idea of the screw, which, if pursued, might have been converted into screw-propelling. In 1768 Painton proposed the pteraphore to be applied to the bow and stern and sides of a vessel horizontally, but does not describe how it was to be moved. Lyttleton also proposed a screw-propeller in 1794. The first practical experiment, however, appears to have been made by Shorter in 1802, with a propeller like the sails of a windmill, applied to the stern of a vessel in the Thames. He afterwards tried several propellers, particularly in the 'Superb' line-of-battle ship in Gibraltar Bay, worked by a screw by the intervention of the capstans, by which the vessel was moved through the water at the rate of about 2 miles an hour.

Shorter does not describe the kind of propeller used in this experiment, although Napier, who afterwards proposed a similar plan without knowing what had been done, when he accidentally found Shorter, had from him an account of his experiments, and saw a large collection of propellers applicable to the bow, stern, sides, and every part of the vessel: Napier acknowledged and admitted that Shorter had conceived almost every possible kind of arrangement, and that his models and plans comprised most of the systems since made public by different parties; Shorter also exhibited several experiments with different propellers, and attributed the best results to a propeller with a single blade projecting from the axis. In 1824 a work was published under the direction of the French government, describing the several modes

of propelling in use in America, on the principle of the screw; one plan was to have a hollow in the bottom of the vessel nearly as long as the vessel itself, with a screw revolving in it to produce motion forwards or backwards; another form of this system was to have a double screw between two boats. In 1825 a company was formed for applying Brown's gas vacuum engine to navigating boats on canals, and a premium was offered for the best invention for propelling boats without paddle-wheels. In 1827 the ingenious and indefatigable Tredgold, in his work on the steam engine, described and investigated the theory of screw propelling; about the same time, or perhaps rather before, Brown, the inventor of the gas vacuum engine, proposed to apply a propeller, consisting of two blades placed at an angle of about 90° to each other and 45° to to the axis; this was intended to be placed in the front of the bow of the vessel, and attached to a shaft working through a stuffing-box, which could be raised or lowered at pleasure. He obtained the premium of the Canal Towing Company for this, and they determined to pursue the subject further; in furtherance of this object, they built a vessel at Rochester with a gas vacuum engine of 12 h.p., which was applied to working Brown's propeller by means of bevil gear; the result of this experiment does not exactly appear, although it was considered sufficiently satisfactory for Brown to continue his investigations: he accordingly built another boat with similar engine and machinery, and made several experiments with it on the Thames, near London, when he is said to have attained the velocity of seven miles an hour with it.

Subsequently, Cameron, Woodcroft, Lowe, Ericson, and others pursued the subject and took out patents for various modifications; nothing, however, was materially effected until 1836, when T. P. Smith obtained a patent for the application of a screw to propel vessels, by placing it in that part of the stern of the vessel called the "dead wood." He accordingly builta small vessel, and made numerous experiments with her on the Thames; this little vessel was 34 feet long, 6 feet 6 inches beam, and drew 4 feet water; in it he placed a small high-pressure engine, with a cylinder 6 inches in diameter, and 15 inches stroke, which was applied to working a screw 2 feet diameter, having a pitch of 2 feet 5 inches. With this vessel he obtained a speed of from 7 to 8 miles an hour; he then tried her on the sea between Ramsgate and London, and she answered very well in driving against the wind in a heavy sea. Upon the success of this experiment a Company, called the Ship-Propelling Company, was formed, Smith being their adviser, and under his directions a vessel, called the 'Archimedes,' of 232 tons burthen, was built in London by Whimshurst; she was 125 feet long and 21 feet 10 inches beam, having a draught of water of between 9 and 10 feet; she was propelled by a pair of engines of the united force of 80 h.p. The engines and machinery, which were made by Messrs. Rennie, instead of being placed transversely in the vessel as was usual in paddle-wheel steam boats, were placed longitudinally; these engines were upon the direct-acting principle, and their power was applied to work the shaft upon which the propeller was placed, by means of two spur-wheels with teeth of hornbeam wood, and two pinions with iron teeth working into each other, the motion of the propeller shaft being 5·33 to 1; or, in other words, when the engine made 25 strokes, the propeller made 133·3 revolutions. The propeller, which was in the dead wood, was united to the shaft, by means of a water-tight stuffing-box passing through the stern of the vessel. The propeller at first consisted of a single-threaded screw; but this not answering so well, another screw was employed, with two threads opposite to each other, 5 feet 9 inches diameter, and 8 feet pitch. The 'Archimedes' obtained a velocity of 9 miles per hour through the water, and proved herself an admirable sea-boat, going head to wind in a heavy sea, and she established beyond all doubt the success of the invention, and its superiority over paddle-wheels in many cases; still, however, much remained to be done before prejudice could be overcome, and before the system could be brought to such perfection as to compete in velocity successfully with paddle-wheels, which had so long and so completely engrossed the public attention as scarcely to leave an opening for any other system; latterly, however, screw propelling has made considerable progress. In 1842, the 'Bee' was constructed by Maudslay and Field for the Government; she was worked by a steam-engine of 10 h.p., adapted for driving either the screw or the paddle-wheel in the same vessel, and thus to try the comparative merits of the two systems. From the trials and experiments made with the 'Bee,' it appeared, that upon the whole the paddle-wheels had an advantage as to speed under all circumstances. In 1840, the 'Dwarf,' of 210 tons burthen, which was the first screw vessel ever commissioned in the British navy, was constructed by Messrs. Rennie; the engines, of 120 h.p., upon the direct action principle, were attached to two spur-wheels, with two pinions for working the screw upon the propeller shaft, on the same plan as the 'Archimedes.' The 'Dwarf' proved herself an excellent sea boat, and attained a speed of 12½ miles per hour through still water. The 'Rattler' was the second screw propelling vessel introduced into the navy. She was 176 feet long, and 32 feet 8 inches beam; drawing 11 feet 3 inches water, carrying 20 guns, and was about 888 tons burthen. The engines, of 200 h.p., were by Messrs. Maudslay and Field; and her screw, which was 10 feet diameter, and 11 feet pitch, was driven by cog-wheels; the screw made 103 revolutions per minute, being in the proportion of 4 to 1 of the speed of the engines; her velocity through still water was 9½ miles per hour, and she proved a good sea boat. All these have been surpassed in speed by the Royal yacht, the 'Fairy,' built for her Majesty, by Ditchburn, with engines by Penn; she is 260 tons burthen, with two oscillating engines of the united force of 125 h.p., driving one spur-wheel and one pinion; the screw consists of two blades, and makes 250 turns per minute, being in the proportion of 5 to 1 of the moving power. The speed of the 'Fairy' is 15¾ miles per hour through the water. The merits of the screw system have now been so completely tested, that the Government have determined to introduce it more generally into the navy, particularly for guard ships; these vessels are to be of two classes, line-of-battle ships and frigates; the former having combined engines of 550 h.p., the latter 350 h.p.; the cylinders of the engines will, in some cases, be applied horizontally, and the pistons will act directly upon the propeller shafts, by cranks, without the intervention of wheels; the propeller shaft will make from 50 to 60 revolutions per minute, and the speed of the vessels will be from 5 to 7 miles an hour; this velocity will be sufficient to enable them to command their own position; and with heavy guns and the free uninterrupted use of their batteries, they will be fully equal to cope with any vessels of their class. The 'Amphion' frigate is also being fitted with a screw propeller, to move with a greater velocity than the guard-ships. She is 1290 tons, was originally built for sailing, and carries 36 guns; she is propelled by a screw of two blades, 15 feet diameter, and 21 feet pitch, driven by a pair of engines of 300 h.p., making from 45 to 50 revolutions per minute; her speed on trial was 7 knots an hour, and promised more; the whole was designed and executed by Messrs. Miller and Ravenhill. To Miller the constructive portion of marine engineering owes much; the forms of framing, the graceful proportions, and scientific combination of strength with lightness; the arrangement of the several working parts of the engines, so as to diminish the weight, and increase their compactness, without impairing their efficiency, have produced the natural consequences, not only in the fast river boats on the Thames and the Rhine, and other rivers where peculiarities of construction were especially demanded, but also in the sea-going vessels, for the mercantile as well as for the Royal Navy and the Post-office service of both France and England.

Much discussion has already taken place, and is still going on, as to the best form and dimensions of propellers; nothing, however, but careful and well-conducted experiments can determine this important point. In these investigations Rennie has taken a leading part; Smith, Lloyd, Sunderland, Barlow, Guppy, Brunel, Airy, Maudslay, Field, Miller, Barnes, Penn, and others have also done a great deal. Up to the present time the double-bladed propeller has produced as good a result as any other form. In the first application of steam power to screw, or stern propelling, cog-wheels were usually employed to drive the propeller; then straps, or bands, working upon wooden or iron cylinders; and in the 'Great Britain,' endless chains were employed; in this case, however, the chain had claws, resembling teeth, attached to it, which fitted into corresponding recesses or cavities, on the drum, and to a certain degree, prevented the stretching or slipping to which chains of the ordinary description are liable; adhesion wheels were also tried by Messrs. Rennie, but were not found so good as cog-wheels. Latterly the system has been much simplified, by applying the piston of the engine to act directly upon the propeller shaft, and a successful result appears probable. Whilst upon this subject, the 'Great Britain,' the largest vessel constructed in modern times, must not be omitted. She is 322 feet long, 50 feet 6 inches beam, draws 16 feet of water, and is 3444 tons burthen. She is propelled by the screw, with a pair of engines of the united force of 1000 h.p.; there are four cylinders, inclining at an angle of 60°, and parallel with the keel; the pistons act by means of cranks upon a large wheel, which turns the drum with the chain and propeller shaft; the diameter of the screw is 15 feet 9 inches. She left Bristol on her first trial on the 8th January 1845; and on the 23rd of the same month, for London and Liverpool,—for New York on the 26th July, 1845, and reached that city on the 10th August; left New York on the 30th August, and reached Liverpool on the 15th September. This vessel and her machinery may be considered as a great experiment, from which useful results may be expected. She has already made two voyages across the Atlantic; and, notwithstanding the prognostications of many as to her failure, according to the report of her able and experienced commander, Captain Hosken, has answered well as a sea boat. Since then her engines and machinery have undergone certain modifications, and some trifling alterations have also been made in the vessel, which experience has proved to be necessary, and which from the novelty of the construction, and the great scale upon which the experiment was tried, might have been expected, and for which every allowance should be made. These alterations have improved her materially; and it is greatly to be desired that so much labour and expenditure should be attended with complete success. This gigantic structure, which has had the advantage of Brunel's assistance, is certainly bold, original, and in the right direction; for nothing but proportionable mass, power, and correctness of form, are calculated to contend with the heavy swell and gales of the Atlantic. It is by these and other well conducted experiments, that we may look forward with confidence, at no very distant period, to the voyage between America and Europe, much as it has already been shortened, being still further reduced. The same may be said of the voyage between India and Europe, the importance of which cannot be too highly estimated.

The advantage of steam, as an auxiliary to sailing vessels in long voyages, the steam power being only applied in calms, or when the wind is unfavourable, is beginning to be generally felt; and numerous vessels are now being fitted out upon this principle. For this purpose the screw propeller, with the means of taking it out of the water and replacing it when required without stopping the vessel, appears peculiarly well adapted; for whilst it enables the vessel to retain all her sailing qualities, as well as her capability for stowing cargo, it still gives her the advantage of steam power when necessary. The steam power, as it is not intended to be the chief agent, should

be compressed into the smallest practicable space, still so as at the same time to give the greatest power: in order to effect this, tubular boilers of the most improved construction and power of evaporation; direct acting engines, in which wrought iron is substituted for cast iron whenever it is practicable, using sufficient steam of a greater density, together with ample stowage for fuel to last for the average probable time that steam power may be required, must be used. By the judicious combination of steam with sailing, the time of long voyages may be materially reduced, and at the same time considerable saving may be effected in the transport of merchandise.

The Electrical Telegraph.

Connected with, and forming a most important adjunct to, the locomotive system of communication, may be mentioned that extraordinary and useful invention, the Electrical Telegraph.

The invention consists in directing a current of electricity through a wire or a series of wires connecting together the intended points of communication. The galvanic or electric current may be produced, either by a battery or by employing the natural electric currents of the earth. The telegraph is worked by handles, which act by means of galvanism upon needles attached to the wires at the other end of the telegraphic line, through which the galvanic current is conveyed, and deflects them to points on a dial-plate, having symbols (according to Cook and Wheatstone's system) or letters or numbers to represent the intelligence to be communicated. By this means intelligence is conveyed from one point to another along the line of wires, almost as soon as conceived, and thus, independent of the advantage as a means of conveying intelligence from one point to another unconnected with the railway, it is of great importance in the working of the railway itself, by preventing accidents; or in the event of an accident unfortunately occurring, enabling assistance to be despatched without loss of time to remedy the evil and clear the obstruction. Several persons claim the merit of this invaluable invention; it is difficult to decide with accuracy upon the claims of priority; like most other inventions, however, it has been perfected by degrees, and each party is entitled to his due share of credit. About the year 1819, Mr. Ronalds, of Hammersmith, is stated to have applied electricity for the purpose of effecting telegraphic communication, and succeeded so far as to complete a current through eight miles of wire. He also employed electricity as a means of communicating motion to a series of wheels. This apparatus, however, was too imperfect to be of much use, but it is evident, that the idea once propounded and partially carried into effect, to a certain extent, establishes Mr. Ronald's claim to the merit of the discovery. In 1830, M. Ampère pointed out the means of deflecting magnetic needles by a current of voltaic electricity, for the purposes of telegraphic communication, and the principles of this discovery have, it is said, been applied to many of the modern electrical telegraphs. The first plan employed was so very complicated, and so liable to get out of order, that it was soon abandoned; but Wheatstone and Cook so completely improved upon it as almost to make it a new invention. Their system consisted of a dial-plate with symbols, to which the deflected needles pointed, when moved by electric agency. At first it was considered that it was necessary that the wires for conducting the current of electricity should be kept entirely isolated in iron pipes; subsequently, however, this was found to be unnecessary. They are now stretched between a series of posts placed at given intervals apart, beside the railway, and a dial apparatus is placed at most of the principal stations, as well as at the termini. The first telegraphic line upon Wheatstone's plan was established, in the year 1839, upon the Great Western Railway, between London and Slough, a distance of 18 miles, and since that time it has been so much improved that it is now generally adopted. It is already complete on the South Western Line between London and Portsmouth, and is being laid down on the North Western and on numerous other lines.

A company, called the Electrical Telegraph Company, has been formed for carrying out the plans proposed by Wheatstone, to whom great credit is due for the perseverance and ability with which he has worked out his system. Bain also claims a right to the invention, and, in addition to the means of electrical telegraphic communication, has invented a mode of printing by it at the same time, thus affording the means of secrecy, and preventing mistakes; for the apparatus being kept locked in a room or box, no one can have access to it but the person to whom the communication is made. Other modifications of the system have been introduced, but hitherto without being extensively employed.

Another valuable application of electricity to engineering operations consists in blasting rock and other materials above and under water. The first effective application of this principle to blasting, may be said to be due to General Pasley, who employed it for blowing up the wreck of the 'Royal George,' sunk at Spithead, in the year 1782, and which, by its own bulk as well as the alluvial deposit accumulated round it, formed a serious obstruction in that important roadstead. Pasley, at the request of the Admiralty, undertook to remove it, and commenced his operations on the 29th August, 1839, by sending down divers, in order to ascertain the exact state and position of the wreck; having done this, he proceeded to place powerful charges of gunpowder in water-tight tin cases in those parts of the vessel where they would have most effect, and they were exploded by an electrical current conveyed through them, by means of wires attached to them, and connected with a voltaic battery placed in a boat floating near: the explosions were instantaneous and almost unfailing, and a great effect was produced: in this manner he succeeded perfectly in removing the wreck in about two summers. The same system was afterwards pursued, in removing the wreck of a vessel in the Thames, and is now generally adopted in similar circumstances. It was applied by Cubitt, at Round Down Cliff, for the purpose of removing a large mass of the cliff on the line of the South Eastern Railway, between Dover and Folkestone: the portion operated upon was several hundred feet long, and between 200 and 300 feet high; the charge of powder consisted of 18,000 lb., disposed in several cells in the line of the intended explosion, and properly tamped with sand: the explosion took place on the 28th January, 1843, and was perfectly successful, removing about 250,000 cubic yards of chalk rock; its success was of great importance to the railway operations, inasmuch as it materially expedited them, and considerably reduced the cost of this difficult portion of the line. This method of blasting upon a great scale is now generally adopted, and enlarges the sphere of operation in this department of civil engineering, as well as in the removal of rocks under water; for which it was used by Rennie many years since. A very successful application of gunpowder, for facilitating engineering operations, has recently occurred in the removal of a number of marl rock shoals in the bed of the River Severn, executed by Edwards, for Grissell and Peto, under W. Cubitt. Martin Roberts also lays claims to the invention; he exhibited his experiments at the Craig Leith Quarries, in March, 1839.

Thompson has proposed to effect the blasting, or rather the ignition of the powder, by means of common electricity, produced by an apparatus enclosed in an air-tight box, so as to prevent the admission of moisture; this apparatus is said to be more simple and less expensive than the galvanic battery.

Clocks.

Connected with the correct working of the railway system, nothing is more important than accurate time-keepers; for upon these depend the regular starting and arrival of the trains, so that one train may not interfere with the other, and collisions be prevented.

The introduction of clocks into Great Britain took place about the year 1288, and, in 1326, Wallingford is said to have constructed a clock regulated by a balance, which was put in motion by weights, but whose action was extremely irregular. The great improvement of the pendulum does not appear to have taken place until about the middle of the 17th century, and the name of the person who first employed it for this purpose is not accurately ascertained. About 1641 Richard Harris is said to have constructed a pendulum clock for St. Paul's church, Covent-garden; however, as Huygens, in 1658, was the first who explained accurately the motion of the pendulum, the chief merit of its application to clocks may be attributed to him. The application of the spiral spring to the balance is due to Hooke in 1658; and the introduction of the compensating mercurial pendulum by Graham, in 1715, was the next great step in improvement; by means of this valuable invention, the unequal expansion and contraction of the pendulum from change of temperature, which rendered impracticable the accurate measurement of time, was obviated. Graham also suggested the idea of employing different metals, having different properties of expansion, so that the one should neutralise the other; his idea was afterwards carried out by Harrison, in the construction of the gridiron pendulum. For the going fusee, the compensation curb, and other improvements, he received a Parliamentary reward.

The scapement, which communicates the sustaining force to the pendulum or balance, demands the greatest skill and accuracy, and various forms have been attempted; amongst others may be mentioned the original scapement-wheel, with its teeth at right angles to the plane of the wheel; the anchor scapement, invented by Clement in 1680; which was improved by Graham, so as to render it more isochronous; the duplex scapement, which does not require such extreme accuracy in the teeth, whilst at the same time it performs equally well: the detached scapement, by means of which the teeth of the scape-wheel always rest on a detent, except when it is unlocked to impel the pallets, is employed in chronometers where great accuracy is required; these, and many other improvements, too numerous to mention, are worthy of notice.

The art of clock or watchmaking, termed horology, may be said to be principally composed of four parts. 1. The moving power, which is generally a weight for clocks or fixed time-keepers, and a spring for watches or moveable time-keepers; in the former case, the line suspending the weight should be equal throughout its calibre, and the cylinder on which it is coiled should be true; in the latter case, the form of the spring should be such that its force may act as equable as possible. 2. The scapement, which communicates the sustaining force to the pendulum or balance: the construction of this demands great skill; there are various kinds, the common crown wheel, the anchor, the duplex, the detached, &c. 3. The means of communicating the power to the minute, seconds, and hour hands, which is effected by a series of wheels nicely proportioned and adjusted to each other, having many of the axes or centres working upon diamonds or rubies, to reduce the friction and diminish the application of oil, which is objectionable on account of its being acted upon by the temperature. 4. The regulator, which is effected by a pendulum in clocks and by a balance in watches. The striking (being merely a secondary part), is easily effected, when the other great points have been determined. The perfection of the art consists in the proper proportions, adjustment, and adaptation of the various parts to each other, and the combination of the several improvements above described; this has now been so completely attained that time can be marked so as not to vary the fraction of a second in a day: for these important and valuable

improvements in this useful and indeed indispensable art, in England, we are indebted to Wallingford, Huygens, Harrison, Graham, Hooke, Cumming, Mudge, Ellicott, Sutherland, Earnshaw, Arnold, Vulliamy, Dent, Frodsham, Parkinson, French, Kater, and others.

Mineralogy and Geology.

Mineralogy, geology, and mining may be said to form an important branch in the profession of a civil engineer. Without some knowledge of these, the engineer will, in many cases, find himself unable to carry on his operations with that degree of certainty and economy, which is necessary to ensure success, and independently of their value in this respect, there are few departments of knowledge which have contributed more to the advancement, comfort, and civilization of mankind; whilst on the other hand, no class has contributed more to the advancement of them than the civil engineer, so that each department is essentially allied to and dependent upon the other. Geology enables the engineer to obtain a proper knowledge of the various strata through which he has to carry his operations; if for a cutting or embankment of a railway, it is essential to know the slopes at which the earth or rock will stand, the value and applicability of the materials excavated for his bridges, culverts, and viaducts, and their capacity for water, &c., in order to form a correct estimate for working through them, whether for his cuttings or his tunnels. If for a canal, the same will apply, with the addition of the knowledge of the sources from whence his supply of water can be obtained: this latter will also apply to waterworks, in which the knowledge of the various qualities of water applicable to the economy of mankind is so essential. In the construction and maintenance of harbours, it is most important to have a thorough knowledge of the geological strata, and of the nature of the coasts where the harbour is to be situated, in order to render it easily accessible to vessels, whether for commerce or refuge, for its construction in the most economical manner, or for its maintenance, in order that the alluvial matter held in mechanical suspension by the adjacent waters shall not fill it up when made. In the management and improvement of rivers for drainage and navigation, in order that they may carry off the superfluous waters from the low lands and marshes, and at the same time maintain the channels in the most efficient state for navigation. In the formation of embankments against the ocean, in order that nature herself may be rendered subservient, as far as is practicable, in affording the requisite protection; in these as in the operations of smelting the minerals of the precious or the more useful metals, geology and mineralogy are of essential service to the engineer and deserve his peculiar attention.

Mining.

Mining appears to have been known and practised in Great Britain from the earliest periods of our history, for the Carthagenians are said to have conveyed tin to Tyre, from Cornwall; but in those early days the operations must have been rude, and merely confined to the surface. This invaluable art made little progress until the knowledge of chemistry, and the invention of machinery, enabled mankind to extract from the bowels of the earth Nature's rich treasures, to investigate their different properties, and to apply them to the purposes of life; the steam engine, which enabled the miner to extract the water and enlarge the field of his operations has been of invaluable service when the ore was raised from the mine, as also aiding in its reduction and the extraction of the metal in its most refined state. Some of the Cornish mines have been extended to a depth of more than 220 fathoms below the surface. As regards coal-mines, they also have been worked to an extraordinary extent, as in the case of the Cumberland coal-fields, which have been wrought above a mile beneath the sea. The total quantity brought to the surface and consumed annually amounts to between 30,000,000 and 40,000,000 of tons. Without the steam engine these operations would be entirely paralysed, and must cease. The total annual value of the British mineral produce is said to amount to about 26,000,000*l*. In this valuable department we are much indebted to the establishment of the Museum of Economic Geology, which will be the means of extending the knowledge and use of minerals, as well as the best mode of obtaining them. Neither must we forget the valuable services of Sir H. De la Beche, Murchison, Sedgewick, Greenough, Buckland, Horner, Lyell, John Taylor, Griffiths, Buddle, Sopwith, Philips, Wood, Atkinson, Bald, and others, who have contributed so largely to the advancement of this important branch of science.

Ventilation.

Connected with mining may be mentioned the important subject of ventilation, the value of which is now so universally appreciated, not only for mines but for public and dwelling houses. The art consists in conveying volumes of fresh air through apartments, so that the air shall be always as nearly as practicable in the proper state for respiration; but in effecting this, it is desirable that the temperature shall not be reduced too low, otherwise inconvenience may be produced in other respects; whilst ventilation, therefore, is of great importance, the artificial warming of apartments is of equal consequence, and to combine both effectually is the great desideratum. Heat is the great medium for producing circulation, as in the example of colleries and mines, and on extraordinary occasions mechanical power may be applied. The common fire-place is the most wasteful of fuel, but possesses many advantages; and, although the stove may produce a more equable temperature, a proper combination of both seems best adapted to unite the advantage of a thorough circulation of air with the required degree of temperature; warm water and steam conveyed through pipes have been employed in many cases; those systems are however the best whereby a large body of air is raised to about 100° by passing between cases filled with hot water, and is enabled to flow freely into the apartments, expelling at the same time a corresponding bulk of vitiated air; thus rendering ventilation an integral portion of the system of warming; by such a plan, warm water may also be supplied to any part of the building for domestic purposes. When stoves are used, they should be upon the principle of slow combustion, and be so contrived as to avoid producing any disagreeable odour; for this reason porcelain is much employed, and it is essential to have a thorough circulation of pure air where stoves are employed. Upon this important subject, much information has been elicited by the late Parliamentary Reports, and by the labours of Sylvester, Tredgold, Arnott, Reid, Hood, Price, C. Manby, Perkins, Haden, Stephenson, and others.

Engineering Architecture.

The pursuits of the engineer are intimately connected with architecture, not merely as regards construction, but in taste also; and, although it is not necessary that he should be so thoroughly conversant with all the details of ornament, as to be able to practise as an architect, still he should be so far acquainted with them as to be able to carry out the leading principles with effect, whenever it becomes absolutely necessary in the course of his practice. The works of the engineer, associated as they are for the most part with the great operations of nature, should be designed and constructed so as to harmonise with them. They must strike by their general mass and proportion rather than by trifling details or minutiæ of ornament, which as a matter of taste, would be misplaced and unnecessary, and wasteful as regards expenditure; consistently, therefore, with their first grand object of fitness for their purpose, they should be simple, and in the few instances where ornament may be necessary, it should harmonise with the structure and be sparingly used.

In architectural masonry, the ancients have left us admirable models which cannot be too much studied, and may be generally followed with great effect and advantage; but the adaptation of timber and iron to modern architecture requires a different treatment. The massive proportions and dimensions which suited well the character of stone are no longer necessary, and would be misplaced when applied to the more solid and tenacious properties of iron; here equal strength is obtained with much smaller dimensions, which, at first sight, from their lightness and apparent weakness (until the eye becomes accustomed to them), produce a feeling of insecurity which can only be overcome by time; but this feeling soon vanishes, and the great convenience, economy, and security introduced by the employment of wrought and cast iron, has caused it to be generally adopted whenever practicable. In order, however, to ensure success, great care must be taken in the selection of proper materials for its different applications, and much depends upon the mode in which it is manufactured; the right understanding of this and of the different processes of converting the ore into the several states of cast and malleable iron and steel, all of which possess very different properties, and require different proportions and dimensions in their application, demands no ordinary skill and experience.

The application of heated air for the purpose of reducing iron from the ore (commonly called the "hot blast" system, invented by Neilson, in 1826), has produced a considerable revolution in the character of the metal, as well as in the economy of manufacturing it, and the comparative merits of hot and cold blast iron is still a subject of controversy, which requires to be duly considered in its application to construction. Cast iron, from the rigidity and brittleness of its texture, is not so well adapted to resist concussion, or any sudden strain, as wrought or malleable iron, and when employed, it is necessary to make greater allowance to meet it; hence the employment of malleable iron has become more general, and has, in many cases, superseded the use of the former, as while it contributes equal strength with less weight, it gives warning previous to fracture, and enables a remedy to be applied, which cast iron does not. For these reasons it is now almost universally employed for all purposes where it is required to resist tension and sudden irregular strains, and to combine strength and lightness; whilst cast iron is only used to resist compression, and to counteract by its mass and rigidity any tendency to movement or alteration of form. By thus carefully studying the different properties of both materials, we soon acquire a knowledge of the best mode of adapting them to their different purposes, and giving to them those architectural forms best suited to their respective qualities and the objects for which they are employed. One of the great advantages of wood consists in the first economy and the facility of converting it to the several purposes where it can be employed, and hence, until the properties of iron and the mode of working it became better understood, wood alone was used in conjunction with stone and brick, both for engineering and architectural purposes; and, notwithstanding it has been altogether superseded for many purposes by iron, nevertheless it still possesses advantages in the construction of bridges, roofs, and other works where the first outlay of iron or stone would be too great. Enough, I trust, has been said, to show the intimate connexion of the professions of the civil engineer and architect, and, without the one usurping the province of the other, it is much to be desired that a harmonious understanding should be cultivated between them, as it must tend to their mutual advantage, and nothing can contribute to this desirable object more than the meetings of this Institution, to which it is gratifying to find so many architects have attached themselves.

AGRICULTURE.

Neither must we forget the comparatively recent adaptation of engineering knowledge to the advancement of agriculture, and the various implements connected with it, for ploughing, drilling, threshing, &c. Since the improvement in the working of iron, the machines for conducting these various operations are constructed with a degree of portability, economy, and efficiency which render them of the greatest importance to the farmer, and enable him to cultivate the soil, as well as to convert its various products to domestic purposes, in a much more economical and expeditious manner than formerly, and to derive a greater profit from his exertions. In the construction of agricultural implements, Messrs. Ransome, May, Cottam, Stratton, and others, have greatly distinguished themselves.

In modern agriculture, under-draining forms an important and valuable principle; stagnant water generally has been proved to be injurious to agriculture, and it is, I believe, now universally admitted that without thorough drainage it is impossible to cultivate the soil effectually; for this purpose small drains formed by tiles laid from 1 foot to 4 feet below the surface, are generally adopted; the tiles are made by machinery invented by the Marquis of Tweedale, Ainslie, and others, at a trifling cost; the surface water is thus conveyed from the land into the adjacent main drains and thence to the rivers. Water is the grand natural fertilising agent, and any amount of care in its proper distribution is well bestowed: it is, therefore, worthy of consideration, whether in hilly countries and districts subject to alternations of dry and wet seasons, it would not be advisable to establish large reservoirs for water, to be used during dry seasons for irrigation, in the manner adopted by the ancients; by this means, districts might be cultivated with advantage, which now are comparatively sterile.

SURVEYING.

Land and Maritime Surveying form an essential department in the profession of a civil engineer; without a correct knowledge of the former, it is impossible for him to lay out and determine in the best manner the proper lines of communication in a district, whether by canal, railway, or common road; and without a knowledge of the latter, it is equally difficult for him to decide upon the best situation for a port, and the most advisable means of improving and maintaining it. In these valuable departments much progress has been made. The great Trigonometrical Survey of the British Islands, which is now very nearly completed, is the greatest work of this kind ever undertaken in this country, and serves as a model for minor works of this nature. It was commenced by General Roy in the year 1783, under the direction of the Ordnance Department of the government, and has been subsequently carried on, with equal ability, by General Mudge and Colonel Colby, of the Royal Engineers, under whose direction it now is. This great work, so far as it has proceeded, has already proved of essential service to the civil engineer, inasmuch as all the towns and villages, the chains of hills, valleys, and rivers, being laid down trigonometrically, his labours, as well as the expenses of his employers, are materially diminished, in tracing out the best lines for railways or other internal communications; instead of having to survey the whole district of his operations trigonometrically, he has only to take the leading points, and to fill in the detail of fields, buildings, &c., to a larger scale; and even before incurring this labour he can, with one of the Ordnance maps in his hand, determine in a great measure the general direction and course of his line; notwithstanding this, it is essential for him to have a thorough knowledge of the use of instruments, the theodolite, sextant, and transit, the most accurate mode of measuring bases, and to see that those employed under him are competent to their task, and employ the necessary means to ensure accuracy in their surveys. Connected with surveying, we must not omit the important department of levelling, for simple as it is, nothing requires greater accuracy,—in fact, upon this being properly done the success of the whole scheme or undertaking in hand may be said mainly to depend; too much attention, therefore, cannot be paid to it; the instruments employed should be of the best construction, simple and substantial, easily adjusted, and kept in good order; the levels should be referred to one datum and proved in various ways, and recorded in a plain intelligible manner, so that they may at all times be easily referred to.

Maritime Surveying requires an intimate knowledge of the general laws which govern the tides, the set of the currents, the prevalence and direction of the winds, the soundings, anchorage ground, &c.; these should be regularly observed for a given period, in order to ascertain every possible variation, and regularly registered and referred to the same datum. For this purpose, self-acting tide-gauges, with a clock apparatus attached to them, for marking the time of high and low water, if placed in proper situations, are extremely valuable: that at Sheerness dockyard, by Mitchell, and the improved one at Ramsgate harbour, are here worthy of remark.

Mineral or Underground Surveying differs from the above in its being necessary to ascertain the dip or angle at which the several strata lay, their general direction and thickness, their quality and value, and the best mode of working them. For laying down the underground survey, the magnet and circumferenter are much employed.

In the investigation of the laws which govern the tides we are much indebted to the valuable scientific researches of our honorary members Lubbock, Whewell, Airy, and others. Connected with the various branches of surveying, the construction of philosophical instruments is entitled to an important station; as without accurate instruments it is impossible to make correct surveys, and for the construction of these we are much indebted to the labours of Ramsden, Troughton, Dollond, Carey, Simms, Watkins, Jones, Elliott, and others.

DRAWING.

Drawing and modelling, although minor, form valuable, and, in fact, indispensable departments in civil engineering; for unless the various projects proposed to be carried into effect, are in the first instance correctly delineated upon paper, it is impossible to convey a just idea of them, or to form a correct estimate of the cost. Drawing may be classed under three heads:—mechanical or geometrical drawing, is that whereby the plans and sections are simply represented as they would appear on a plane surface; perspective drawing consists in representing the objects as they appear when seen from a given distance and height; this kind of drawing, although very useful, and indeed indispensable, to the architect, in order to represent the true effects of light and shade of his different compositions, as they would appear when carried into effect, and upon a true perception of which, the success of his building will mainly depend, is not of that importance to the engineer, whose works are of a different kind, and much more extensive, so that to represent them perspectively would in many cases be impracticable; but inasmuch as in detached portions of his works, such as important bridges, viaducts, machinery, &c., perspective drawing may be employed with great advantage, it ought to be studied. Landscape and topographical drawing is also useful, in order to convey to unscientific persons an idea of a particular locality, in the manner they are accustomed to view it, where works are proposed to be executed, and thus to remove fancied objections which otherwise might be overcome with difficulty; and this is still more successful with the application of colours when applied as seen in nature. These different kinds of drawing should be carefully studied and practised with accuracy, as they will be found essentially to forward the views of the engineer, and give satisfaction to his employers.

Although drawing, however, is most valuable, modelling in many cases is essential: for in the former case the objects are merely represented upon paper, assisted by light and shade and perspective, which, to persons in some measure acquainted with the subject, conveys a tolerably correct idea of what is proposed to be done, but a model represents it (although upon a reduced scale) exactly as it is intended to be, with the different planes, dimensions, and surfaces; hence, nothing, except the work itself, gives such a perfect idea or representation as a model; it also enables the engineer to detect many imperfections which otherwise would escape his notice; whenever, therefore, models can be conveniently adopted or employed, it is advisable to do so; and it is gratifying to know that the art of modelling has made considerable progress, so that now they can be obtained at a moderate cost in wood, card-board, plaster, and clay, and will thus be more generally employed. In this department Salter, Deighton, Day, and others, have attained deserved celebrity. Working models of machines are extremely useful to give an idea of the action of a machine, but we should be cautious in drawing conclusions from the results, for it too frequently happens that a machine succeeds extremely well when tried in a model, but fails when put in practice; we should, therefore, merely consider the results of working models as guides to be worked out practically.

METEOROLOGY.

The principles of this science, as far as they have yet been determined, claim our particular attention. Without a knowledge of the winds, and the quantity of rain falling in a particular district, we cannot determine with precision the proper form and dimensions of moles or piers to resist the action of the sea, or of drains to carry off water from extensive districts of marsh land, or of the extent to which it may be necessary to improve the channels of rivers; or in carrying lines of railway through a country, to design the works in such a manner that they may withstand the shocks of the elements; neither can we select the proper kind of stone or other materials for constructing buildings, unless we know the vicissitudes of climate to which they may be exposed, or the extent to which they may be acted upon by it.

In the investigation of the phenomena of this difficult science, we are much indebted to the late Professor Daniell, and to C. H. Smith, whose report upon the qualities of the different kinds of stone, as regards their tenacity, hardness, capability of resisting moisture, and durability, for the purpose of selecting the best material for the new Houses of Parliament, forms an important and useful example, for which the engineer and the architect are much indebted, and the same course should be followed, as far as is practicable, previous to commencing every great work, and indeed, for the want of it, we now find many magnificent buildings partially decayed, which otherwise, would have been in excellent preservation.

PATENTS.

The improvements in manufactures, machinery, and other branches of art, resulting from a great number of curious and valuable inventions, necessarily gave rise, on the part of the successful inventors, to a desire to secure for themselves and their posterity, as far as is practicable, the benefits of their labours. The Government, perceiving and duly appreciating the advantages which not only the inventors themselves, but the nation at large, derived from them, wisely resolved to give every possible encou-

ragement, by securing to them the exclusive right and title to their inventions for a certain number of years, and to enable them to recover, by legal process, severe penalties against any person attempting to use their inventions, without the previous consent of the inventors themselves. Hence arose the Law of Patents, or a privilege of the Crown to grant letters patent, conveying to the persons mentioned therein, the sole right to use or dispose of any new invention or discovery for a limited period, which is generally about fourteen years. It is difficult to fix the date of the first assertion of this privilege of the Crown, but it was first defined by statute in the reign of James I. The law has at various times undergone certain alterations and modifications, so that it now forms a branch of itself, which, with its various complicated relations, demands a peculiar study. Ever since the reign of Anne, parties have been compelled to specify in detail the particulars and nature of their invention or discovery, previous to obtaining royal letters patent.

The great number of inventions, which have multiplied considerably of late years, has given rise to an important class of professional gentlemen, styled patent agents, who devote themselves exclusively to the study of inventions and the pecular laws relating to them, in order to secure to inventors their just rights and prevent them from being infringed upon by others. Amongst these gentlemen we may mention the names of Robertson, Newton, and others, to whom inventors are much indebted for the skill and attention with which their interests are guarded, as also to Godson, Holroyd, Hindmarsh, Rotch, Webster, Farey, Carpmael, and others, who have devoted themselves to the study of the Patent Laws, and have written ably upon them.

Theory and Practice.

In the preceding pages, my remarks have been almost exclusively confined to the notice of the various works which have been carried into effect by civil engineers since the time of Smeaton; and although practice, upon the whole, is most important, nevertheless, we should not omit the study of the theory or principles upon which that practice is, or ought to be, founded, and without the due study and comprehension of which, we may frequently be led into great errors in practice. Our junior members should, therefore, previous to commencing their professional career, be well versed in arithmetic, algebra, mathematics, mechanics, and the principles of natural philosophy in general, and the mode of applying them to practice. They should cultivate a patient and equable temper of mind, in order to enable them to investigate, with rigid impartiality, the principles so beautifully illustrated in nature, and upon which the great operations which may hereafter be intrusted to their charge as civil engineers depend; and once having found out, and thoroughly understood, these principles in all their various applications, they should never depart from them; always bearing in mind, that nature will submit to assistance and guidance for the benefit of mankind, but never to opposition with impunity; her laws are immutable, and we may be assured that, either for good or evil, the same causes will produce the same effects: if, therefore, we wish to command success, we must adhere to her laws, and when we once thoroughly understand them, we shall be amply rewarded for all our toil; difficulties will vanish, and success will invariably attend our efforts. Previous to commencing practice, our junior members should not neglect the workshop; on the contrary, it would contribute materially to their advancement to undergo an apprenticeship of some years in that department; for inasmuch as the success of many of the works in which they may hereafter be engaged, particularly the mechanical, depend in a great measure upon the correct application of the principles which can be only thoroughly learned in the workshop, that is the place in which they must be studied; moreover, it will imprint indelibly in their minds the principles which they acquire from books, and induce a degree of accuracy of thought and execution which cannot be acquired elsewhere; hence we find that some of our greatest engineers, both of the past and present age, have there acquired a considerable portion of their education, and owe a great degree of their celebrity to that invaluable nursery for engineers. Nothing, therefore, can be more erroneous than to suppose that theory and practice are incompatible with each other, for they are intimately connected with and dependent upon each other. Without a thorough understanding of the theory or principles upon which engineering is founded, it is impossible to carry them into practice without endless failures and wasteful expenditure of means; and without the experience derived from practice, the principles acquired from theory will be of little avail; both, therefore, must be carefully studied and combined in order to produce a good engineer. Finally, composition, or the art of putting ideas into simple, clear, and intelligible words, should be studied, in order to convey to the world just notions of the measures proposed; also an intimate knowledge of the value of materials and workmanship, in order that he may be enabled to make correct estimates, upon which the success of all commercial undertakings so materially depend.

Continental Engineers.

In making the foregoing remarks, I have endeavoured to confine myself strictly to what has been done by civil engineers in England during the past and present centuries; but in so doing, I should be extremely sorry to be considered as detracting from, or underrating in the least degree, the great merits of continental engineers, or the progress which has been made by them also during the same period, and we are proud to number many of them among the members of this Institution. To attempt to enter upon this equally interesting and instructive subject, would compel me to trespass much longer upon your patience, which I fear has been already tried too much; but I cannot omit remarking, that the greatest credit is due to our professional neighbours on the Continent, for the example which they set in the infancy of the science, when it was so little known in this country, and for the great progress which has subsequently been made, and the numerous inventions which have emanated from them. In Italy, we have only to mention the harbours of Genoa, Venice, Ancona, Civita Vecchia, Leghorn, and Naples; the canals and silk machinery of Lombardy; and the names of Leonardo da Vinci (said to be the inventor of the pound lock), Gugielmini, Frisi, Manfredi, Martinetti, Fazio, Miliani, and numerous others. In France, the mole and docks of Cherbourg, Toulon, Brest, Havre, Boulogne, Calais, and Dunkirk; the canals of Languedoc, Burgundy, and Picardy; the embankments of the Loire; the bridges of Neuilly, Bordeaux, the Dordogne; and the names of Belidor, Papin, Gauthey, Rondelet, Dupin, Perronet, Prony, De Cessart, Lambarde, Reibel, Sganzin, Frissard, Hallette, Navier, Jacquard, and others. In Switzerland, the Alpine roads of the Stelvio, Mont Cenis, St. Gothard, the Splugen, the Brenner, the Simplon, &c. In Holland, the magnificent embankments for defending the country from the sea; the great Texel, and numerous other canals. The system of drainage, although perhaps too complex and artificial, is also meritorious and worthy of remark. Throughout Germany, the system of managing the great rivers Danube, Rhine, Elbe, the bridges across them, the canals connecting them together, as well as the roads and mining operations. In Sweden, the docks of Carlscrona, and the Trohlhatta canal. In Russia, the docks at Cronstadt and Revel, the extensive inland navigation, roads, &c. In Spain, the moles of Malaga, Alicant, Tarragona, and Barcelona; the docks at Ferrol, Carthagena, and Cadiz, and the Arragon canal; and the railway system, which owes its origin to this country, is now making rapid progress everywhere on the Continent. Neither must we omit to mention the ingenuity and vigour of our transatlantic brethren, the United States, to whom the world is much indebted for their many splendid public works and useful mechanical inventions and discoveries.

Conclusion.

I have thus endeavoured to take a rapid survey of the different departments which constitute the profession of a civil engineer, since the commencement of the last century, or rather, from the time of Smeaton, down to the present day. Imperfect, however, as this survey has been, I fear it has trespassed too much upon your valuable time, although the interest and importance of the subject justly entitle it to an extended notice, and would amply repay the perusal, if it had been treated by an abler hand, at even a much greater length. Looking back to the humble goal from which we started, a little more than a century since, and then adverting to the exalted pinnacle upon which we now stand, what almost immeasurable space have we traversed—what triumphant progress have we made! In how great a degree have both public and private prosperity, and the civilisation of mankind, been promoted by it. Within a few years our profession was comparatively unknown, and the great and beneficial results which have sprung from it were never anticipated; now it is universally in the ascendant, and it may be so with reason, for without presuming to undervalue the merits and importance of other professions, that of the civil engineer may be said to embrace everything which can tend to the promotion of the comfort, the happiness, and the civilisation of the human race, and to be established upon principles of the very highest order.

Comparatively speaking, only a few years have elapsed since Great Britain, as regards engineering works, was in a very backward state: she had neither roads, canals, harbours, machinery, nor manufactures worthy of being compared with those of her neighbours on the Continent. Let the comparison be made now, and we find that if we do not surpass every other nation we are inferior to none. And to what may this extraordinary change be attributed, but to the progress of civil engineering? Notwithstanding, however, we have advanced thus far, much still remains to be done. Great as has been the result, we may be said scarcely to have passed the threshold of improvement. It is true we feel the influence of our position, but this can only be maintained by future advancement. To stand still is to retrogade; our career must be onward; and what has been done should only serve as a stimulus to greater exertions. We have still a very wide field before us; let us, therefore, by our exertions, cultivate it to the very utmost; let us never rest satisfied so long as anything remains to be done.

Much yet remains to be discovered in the formation, construction, and maintenance of harbours, in order to afford the greatest facility of ingress and egress under all circumstances, without at the same time diminishing the necessary protection and depth;—in the improvement of rivers, so as to enable them to drain and carry off the floods effectually from the adjacent marsh-lands and valleys, and at the same time to render them capable of navigation to their utmost extent; to point out the most effectual means of enabling them to discharge their fresh waters into the sea or estuaries, and to receive the tidal waters without causing them to deposit the alluvial matter held in suspension by their waters, in such a manner as to form injurious bars or shoals;—in determining the best form and construction of vessels, so as to render them capable of giving the least resistance in their passage through the water, and conveying the greatest burthen or cargo with the utmost safety and velocity;—in determining the best form, dimensions, and construction for locomotive engines for any gauge, so as to combine the utmost capability of producing steam, with the least quantity of

fuel, and drawing the maximum load with the greatest velocity, combined with the greatest safety and economy;—in determining the proper width of gauge which shall satisfy all the required conditions of safety, economy, and speed; in determining the most expeditious, safe, and economical means of transferring goods, passengers, and carriages from one line to another, whenever a break of gauge becomes necessary;—in determining the best and most economical mode of constructing and laying down the permanent way, in such a manner as to enable the trains to travel with safety, at the greatest speed the engines are capable of producing, with the least wear and tear either to the permanent way or to the engine and carriages;—in determining the resistance of railway trains; in devising means for obviating the leakage by the valve in the atmospheric system; in discovering a substance for sealing the valve which shall preserve the desired consistency under all degrees of temperature; and in generally investigating that system of traction, in order to remedy any practical defects which may exist, and to ascertain when it may be applied with the greatest advantage;—in the improvement and adaptation of machinery to many new objects in the arts and manufactures, and in the application of chemistry and geology to our operations.

These, and a variety of other improvements, are to be desired, and are worthy of our particular attention and study. The steam engine itself, improved as it is, and wonderful as have been the results produced by it, is capable of further improvements. Its bulk and weight may be further diminished, both in the form and construction of the boiler as well as in the engine itself, and thus, in effect its power may be increased; or it may be reserved to us to discover the means of producing and rendering subservient to our purpose some other power which shall surpass steam, or, perhaps, to substitute for it that all-powerful agent electricity, which Jacobi has already attempted to apply to navigation. Obscure and difficult as the subject may appear now, it may still be realised. Our indefatigable and enlightened honorary member, Faraday, has pointed out the way, and is still proceeding in his distinguished career with remarkable success, and we must not lose the opportunity of profiting by it: in fact, by well-directed and combined exertions, it is impossible to foresee the results which may yet be arrived at.

This Institution, which but a few years ago was scarcely known, has now taken its station amongst the first scientific societies of the kingdom; and as its objects are second to none in importance, whether as regard their public or private utility, so must it continue to flourish and increase in importance if those objects be only legitimately and steadily prosecuted. In order to effect this we must not relax in our exertions, there must be no schism among ourselves; the Institution must be our rallying point; we must all work for the common good. We must contribute to its advancement, as well as that of our profession, by every means in our power—whether by papers, by verbal discussions, by contributions to the model-room or the library, or by the construction of works which shall serve as examples worthy of being followed—in fact, in every practicable manner, each according to our several opportunities.

Let the senior members, both by their precept and example, and their forbearance, courtesy, and assistance towards each other, with liberal and right minded zeal, for the honour of themselves and their profession, point out to the junior members the true road to eminence; and as they, by the common lot of mortality, must quit this transitory scene, let them be succeeded by others fully competent to fill their places, and to enlarge the boundaries of their profession.

On the other hand, let the junior members look up to their seniors as friends, and as sure guides to follow, and from whom we may with confidence seek for assistance in the hour of need; and, banishing all jealousies or other ignoble feelings, let them rally round and support their seniors under all circumstances. Let the chair of this Institution be an object of honourable ambition to the youngest graduate, as a goal to which he may look forward as one of the rewards, and that not the least, of his successful exertions in his professional career.

By thus pursuing steadily, with one vigorous and sure effort, this grand object—the elevation and advancement of the profession—we shall have the proud satisfaction of finding that our exertions will be crowned with success; that the Institution, as well as ourselves, will flourish; and, what is a far nobler achievement, we shall find that by removing, or, at least, diminishing, as far as may be practicable, all physical obstacles by sea and by land to the free communication of nations with each other, and by the invention of new machinery, or other means, to supply their mutual wants, we shall ultimately understand our true interests. Prejudices and national jealousies will vanish, and instead of exterminating each other by that greatest curse of mankind—war, we shall become bound to each other by the ties of peace, and united like one great family, striving together for the benefit of the human race.

A Great Bridge.—The new railroad bridge across the Susquehanna, at Harrisburg, is an immense structure. It is about 4,000 feet long, built upon the improved double-latticed plan. There are 23 spans, averaging 173 feet each; and two arched viaducts, one 53 feet, and the other 84 feet long. The entire cost of this immense structure is short of 100,000 dollars.—*American Paper.*

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

ROYAL SCOTTISH SOCIETY OF ARTS.

March 22.—DAVID MACLAGAN, M.D., F.R.S.E., President in the Chair.

The following communications were made:—

1. "*On the Principles employed in the Decoration of the Room for the Meetings of Proprietors in the Commercial Bank of Scotland, Edinburgh.*" By Mr. D. R. HAY.

Mr. Hay showed that there is a demonstrable truth in ornamental design, which constitutes its beauty, independently of any fancy or whim in the individual to whose inspection a work of this kind is presented, and without any reference to what are called the styles of ornamental design; and that this truth was of a mathematical nature, and so far teachable, as to enable the decorator to produce perfect symmetry of form and harmony of colour in almost infinite variety, without copying or even imitating the works of others. Thus proving that we might have a style of decorative ornament belonging exclusively to our own country and our own period. He showed also that the beauty thus produced differed from picturesque beauty, in so far as the former is teachable, while the latter is exclusively the province of genius. In doing this, he referred to the immense quantity of counterfeit high art produced at the present day, and the bad effects of ingrafting this counterfeit upon ornamental design, instead of inculcating the first principles of symmetry of form and harmony of colour. He pointed out what he conceived to be the fallacious proceedings of the Government Schools of Design in these respects.

Mr. Hay next referred to the appropriateness of various kinds of ornamental design, and held up to ridicule the egregious blunder committed by the German decorator, Herr Sang, in the piazza of the Royal Exchange, London, who, instead of following up the architect's idea of massive strength, or referring to the use of the edifice, has bedecked it with a species of (*ornament!*) at once meaningless, flimsy, and fantastic. He then proceeded to show that the decorator ought, on all occasions, to endeavour to follow up the original idea of the architect, and impart the same feeling by his colouring, that the latter had imparted to the general construction and architectural decorations, which, although now generally finished in lath-and-plaster work, imitated, in their configuration, either the marble employed originally in the classical styles of architecture, or the wood employed in those of the middle ages. He then showed that the imitating of marbles and woods was closely allied to high art, and the prejudice against these species of imitative art arose from its being often employed in churches and other public buildings, which are generally painted at the lowest estimate, and consequently exhibit this branch of the decorative art as performed by the lowest grade of artists.

In respect to the principles adopted in the style of decoration employed by Mr. Hay on the ceiling and walls of the room appropriated to the meetings of the proprietors of the Commercial Bank of Scotland, he showed that it depended for its beauty simply upon a combination of geometric with chromatic harmony, being the practical application of a theory which had met the approval of Sir David Brewster, who had also suggested its application to the decorative arts. Mr. Hay, in referring to the great hall of the Society of Arts in London, where he had first introduced this new style of decorative painting, said, that its being in that case necessarily confined to the ceiling, did not put it fairly to the test; but that the walls as well as the ceiling of the proprietors' room in the Commercial Bank being decorated in this way, that apartment might be said to be the *first* in which this new style had been properly exhibited.

Mr. Hay exhibited two finished specimens of the work, with five explanatory drawings. The first specimen was that applied on the ceiling panels, and arose out of a diagram in which the equilateral triangle and circle were harmoniously combined. The second specimen was that of the pattern applied on the walls, which he showed arose from the combination of elliptic bands. Both these specimens represented mosaic or inlaid work, composed of *lapis lazuli*, gold, *giallo-antico*, and *rosso-antico*, while the five explanatory drawings showed the simplicity of their construction, and the nature of their harmony. Mr. Hay referred to a work upon ornamental design, which he published some years ago, for more ample details, and concluded his paper by referring to the ornamental decoration of the title-page and dedication of the *Art-Union Journal*, as examples of the low state of that art in the metropolis, and how much still remained to be done for it even there.

2. "*Drawings of a Patent Atmospheric Railway Valve.*" By PETER FAIRBAIRN, Esq.

This valve seemed to be admitted to be perhaps the most perfect of the kind yet invented. There is no hinge and no necessity for grease to fill up the chinks of the valve. The valve itself consists of strata, so to speak, of different substances:—1st, iron, strong but gently flexible, occupying the lower portion and filling neatly the longitudinal cavity of the exhausting tube; 2nd, vulcanized india-rubber, a little larger, so as to overlap the iron; 3rd, wood, to press down upon the india-rubber, but leaving the sides of the latter free; 4th, strong leather fitting the top of the flange of the tube, which is ground flat, to receive the sides of the leather, thus giving along with the india-rubber a double security to the vacuum; and 5th, a band of iron again, broader than the leather, and bending down at the edges so as to

protect it. The inner and outer bands of iron are the portions of the valve on which the wheels act in opening and closing it. The whole valve is lifted out of its seat by the inner wheels during the passage of the piston, and is again replaced in it by one of the outer wheels. It was stated that the specification had been enrolled in October last.

3. "*Improvements in Railway Carriages.*" By Mr. JAMES WIGHT.

Mr. Wight exhibited a full-sized drawing of his proposed carriage wheels, having the tire at an angle of 45 degrees to the rails, entirely obviating the rubbing and shearing friction of the present wheels, while the load is sustained by the second set of spokes converging at the upper journal of the axle, perpendicular to the rail. His proposed conical form requisite for the periphery of the driving wheels was also exhibited, adapting themselves to the curves over which they pass, and moving freely round without any slipping of the wheels, or twisting of the axles, resulting from their present form; and entirely dispensing with the clumsy artifice of watering the rails from the locomotive, designed to assist their sliding when compassing a curve,—a property the reverse of which is of the utmost importance to the utility of the locomotive. He also suggested an improvement in the mode of traction, by appending the drag hook at the head of a single buffer rod issuing from the centre of each carriage, in place of one from each side as at present, the end of each rod being made to comprehend two convex springs, which are placed under the centre of the carriage, so that either in the traction or propulsion they are compressed simultaneously, and the concussion is sustained at the centre of the carriages without the slightest tendency to throw them off the rails.

April 12.—GEORGE TAIT, Esq., V.P., in the Chair.

The following communications were made:—

1. "*New Method of Ventilating Public Buildings*, Churches, Schools, Dwelling-houses, &c., by means of Hot-Water apparatus placed at the roof of the building, for extracting the exhaled air;"—successfully employed to ventilate various buildings. Designed and applied by Mr. ROBERT RITCHIE.

Mr. Ritchie gave a short account of the methods which have been usually employed in ventilating buildings, and showed that, as the object was to induce a current from a difference in temperature, the plan he had in previous communications suggested (1843-4), of making use of the heat from hot water or steam, afforded a safe and efficient medium for extracting the exhaled air from apartments. He had since had several opportunities of carrying his views into effect in large buildings, and the result has been quite successful. He then described the method he had adopted at the Justiciary Court-house, Glasgow, and elsewhere. A powerful hot-water apparatus of patent tubes—raised to a high heat, and supplying themselves with water—is placed in a small chamber at the roof, and is heated by a furnace placed at the basement of the building. The apparatus acts as an artificial fire, and from the rarefaction of the air within the chamber the exhaled air from the apartment to be ventilated is drawn towards it, through the ventiducts formed over the ceiling, and rises or is expelled through an elevated chimney or shaft into the atmosphere—the heated current being protected from the action of the wind by means of turncaps or screens.

Mr. Ritchie showed the arrangements he had provided for the regulation or control over the velocity or movement of the air in the room. He pointed out, amongst other advantages of this mode of ventilation, that it was free from all risk of fire, as the furnace might be 50 or more feet from the heated chamber at the roof; that the air within this chamber admitted of simple means of increase; that there was no risk of the reflux of the exhaled vapours, and, even were it so, these could, by no possible means, be mixed with the products of the combustion of fuel: that the apparatus was simply managed, and the expense not greater than other plans in use. He likewise showed the necessity of combining, with every plan for extracting the exhaled air, an adequate supply of fresh air—that buildings, whether heated with or without open fires, should have the means afforded for obtaining a continued supply of moderately warmed air in winter, to replace that which is vitiated by respiration and gas, or which goes off by chimneys. He showed the plan he had adopted for warming the Court-house, Glasgow, and the Commercial Bank, Edinburgh, with simple hot-water apparatus, which afford supplies of fresh air, duly regulated in temperature and humidity. He concluded with pointing out that the principle of the ventilation described was equally applicable to domestic as to public buildings; that a great many rooms might be ventilated with the same hot-water apparatus placed at the roof, and heated at the basement; that the architect (W. Nixon, Esq.) for the New Police Buildings, Edinburgh, had adopted this plan for extracting the exhaled air from the cells and other rooms; that whole tenements (so important to salubrity) might thus be ventilated; for the capabilities of the patent screw joint apparatus was such, when combined with the ingenious systems of continuous circulations, that as much 6000 feet of pipe can be heated with one small fire.

2. "*Improved Chimney Cans or Fumi-Expulsors*," for the Cure of Smoke and Blow-downs in Chimneys. By Mr. JAMES STEWART, jun.

The principle on which these chimney-cans are invented, is to prevent the inconvenience of smoke being sent back into apartments by high winds or by change of wind; and to have the construction of the chimney-cans such as to improve the draught, and to present no obstacle to the free egress of the smoke, nor to the cleaning of the vent; while, in ordinary circumstances, no undue accumulation of soot can possibly arise. The cans being stationary, are less liable to go out of order than the moveable ones in common use. Mr. Stewart stated that their operation had been quite successful, and that they had cured of smoke rooms which before had scarcely been habitable. These cans can be made in galvanised iron from 23s. to 30s., or in clay for 10s. 6d. The valve is fixed on the chimney-top or can, to prevent back smoke or down-draught, and is operated upon by a wire or chain from the fire-place.

3. "*Self-acting Cart-Drag or Break*," which is worked by the Horse itself. By WILLIAM RUTHERFORD, land-steward to the right honourable Lord Douglas.

This break can be fitted up on any two-wheeled cart or coach, with shafts, at a very moderate expense, from the simplicity of its machinery. It consists only of the following parts:—Two wooden rubbers, applied in front to the rims of the wheels, are connected with each end of a cross-bar of malleable iron, $1\frac{1}{2}$ inches deep and $\frac{3}{4}$ of an inch thick, placed at right angles to the shafts, and horizontally, below the body of the cart in front of the wheels. This cross-bar is held in its place by keepers of iron attached to the outside of each shaft, leaving abont $3\frac{1}{2}$ inches of space for the cross-bar to move backwards and forwards, so that the rubber may be easily withdrawn from or applied to the wheels. To the cross-bar are attached two iron rods, $\frac{5}{8}$ths of an inch in diameter, running each below a shaft, and parallel to each other. Two keepers retain each rod below its shaft, and allow it to move freely backwards and forwards. A hook is attached to each rod about two inches from their ends, so that when the horse is yoked by the shoulder and back-chains in the usual way, the back-chains are attached to the hooks. The horse has thus the power, when urged by the load behind, on a steep incline, to press back the rubbers upon the wheels, and retard their progress to any extent desirable. When the rubbers are not required to act, such as when the horse is pulling forward on a level, or going up an incline, the break is kept from touching the wheels by a spring fixed behind the cross-bar to which the rubbers are attached, and pressing that bar forward. Finally, two small keepers and hooks, at the ends of the rods, are used for the purpose of preventing their motion when backing the cart.

4. "*A new Regulating Index for the Pendulum.*" By Mr. JAMES M'EWAN, watchmaker.

The bob of the pendulum is made in two halves, being hollowed in the centre, so as to admit a contrate wheel, carrying on its arbor an index-hand which points on a dial-plate in front of the bob to the words fast or slow; the nut at the bottom of the pendulum being turned, it acts on the wheel by a pinion, and thus any person who has occasion to regulate the beat of the pendulum can see by the index-hand how far he raises or lowers the bob. Of course, Mr. M'Ewan intends this merely for common domestic clocks, and not for fine time-keepers, whose rate would be affected by the mere motion of the index-hand round the dial-plate of the bob.

5. "*An Alveolar Hæmorrhage Compress*," for suppressing undue Bleeding, resulting from the Extraction of Teeth, constructed by Dr. ROBERT REID, dentist, was exhibited.

6. Specimens were exhibited of Mrs. H. MARSHALL'S "*Patent Intonaco Cement*," the inventor stating that although only half-an-inch thick upon the lath, its capabilities of resisting fire were very great, and indeed, might be subjected to a trial by fire for a considerable time, while the lath behind it, and in contact with it, would scarcely be singed.

A list of Prizes to be offered for Session 1847-8 was submitted by the Council and approved of, and ordered to be printed and advertised as usual. (See Advertisement.)

SOCIETY OF ARTS, LONDON.

March 31—WM. POLE, Esq., F.R.S., V.P., in the Chair.

M. RICARDO, Esq., gave an account of his "*Indicator for ascertaining the Speed of Railway Trains.*" The machine consists of a pair of governors, to which motion is given by means of a band working on a horizontal wheel, attached to one of the carriages; as the speed of the train increases, the governors fly open and pull round a hand, which points out, on a graduated dial, the number of miles per hour at which the train is travelling. The governors are prevented from flying open with a jerk by two pieces of vulcanized india-rubber, which lengthen gradually as the speed of the train increases.

The Secretary read a paper by Mr. T. R. CRAMPTON, "*On the working of his large-wheel narrow gauge Locomotive Engine, the 'Namur,'*" for the design for which he last session received the Society's Gold Isis Medal.—The author having made some remarks on the statement put forth by him last year, as to the advantages possessed by an engine built on his principle over those on the old plan, proceeds to give the following account of the Namur:—

The Namur is a six-wheeled engine, with the whole of the working parts outside.

Diameter of the driving wheels	7 ft. 0 in.
do. supporting do	3 ft. 9 in.
Distance between centre of the extreme wheels	13 ft. 0 in.
Diameter of cylinder	0 ft. 16 in.
Length of stroke	0 ft. 20 in.
Number of tubes	182
Length of ditto	11 ft. 0 in.
Diameter of tubes, outside	0 ft. 2 in.
Length of fire-box	4 ft. 3 in.
Breadth of ditto	3 ft. 5 in.
Area of fire-grate	14 ft. 6 in.
Surface in fire-box	62 ft. 0 in.
Surface of tubes, inside	927 ft. 0 in.
Total surface	989 ft. 0 in.

This engine is constructed for the Namur and Liege Railway, and has run on the London and North Western Railway, with every variety of train, a distance of 2300 miles. In the course of the experiments the following speeds have been reached:—With a train of trucks loaded with coke, and weighing 80 tons, exclusive of engine and tender, 51 miles per hour on a level;—with a train weighing 50 tons, 62 miles per hour was attained, between Tring and Wolverton. But the most severe test an engine can be put to is when it has no train behind it: an experiment of this kind was tried with the Namur,—Capt. Addington, inspector general of railways, and Capt. Simmonds, his assistant, being on the engine at the time, with which a speed of 75 miles an hour was attained on level ground, going round a curve between London and Harrow. The speed was taken by Captains Addington and Simmonds, and both were perfectly satisfied with its steadiness at that rate of speed. A second engine is building for the North Western Railway with 8 feet driving wheels.—The author concludes by offering, at an early date, to furnish an account of the expense of working the engine, and the consumption of coke, water, &c.

Mr. HARDING observed that Mr. Crampton had done perfectly right by increasing the dimensions of the fire-grate, for while the heating surface of the ordinary engines has been quadrupled, the fire-grate has not been increased 30 per cent. He considered that the experiments, as far as they had gone, were quite satisfactory.

Mr. M'CONNELL considered that the engine had performed very well,—and that Mr. Crampton might congratulate himself on having lowered the centre of gravity, and increased the area of the fire-bars and the size of the driving wheel.

April 14.—THOMAS WINKWORTH, Esq., in the Chair.

The secretary read a communication from Mr. W. C. FULLER, on his "*Vulcanized India-Rubber Buffers for Railway Carriages.*" The invention consists in substituting a series of rings of india-rubber, separated by iron plates, for the ordinary spiral spring. The buffer-rod passes through the centre of the rings, and is protected from being bound by the india-rubber when compressed, by means of a conical flange affixed to the iron plates. The advantages which this invention appears to possess over the ordinary springs are—great reduction in weight—less liability to get out of order—greater facility of increasing or decreasing the power of the spring—and its ready applicability to carriages already constructed, without increase of cost.

Mr. RICARDO wished to know what would be the compression of the buffer under ordinary circumstances—supposing the length of the india-rubber employed to be 3 feet?

Mr. FULLER stated, that the length of stroke required for the buffer is from 10 to 13 inches; that the ordinary strength of the present springs is from 3 to 3½ tons; that is, 3 tons reduces the circular spring to a flat, while the India-rubber is capable of resisting from 5 to 50 tons.

The next communication read was by Mr. PHILIP PALMER, "*On the Application of Crown Glass Metal to the Manufacture of various Domestic and other Articles.*"—The author commenced his paper by stating, that he did not intend, on the present occasion, to claim the attention of the Society to works of art in glass, but to such as are of recent manufacture, and have arisen out of the repeal of the duty on that material. Before the repeal of the duty, crown glass was only used for glazing windows and for prints, while the various articles for the table were made from flint glass. After describing the difference of manufacture employed in the crown and flint glass, he proceeded to enumerate some of the articles which are now being made of crown glass, and which were never before made of glass; among them were the following:—A glass dairy pan, for setting of cream; the advantage of using glass, instead of zinc, tin, or lead, is its producing a larger quantity of cream—equal, it is stated, to from 30 to 50 per cent. The next articles enumerated were propagating glasses, for horticultural purposes; these supersede the use of metal frames, bee and grape glasses, cucumber tubes and seed protectors, pantiles for roofing, and for domestic purposes, glass pipes, pickle jars, rolling-pins, pastry pans, jugs, &c.

The author having also shown the application of crown glass for coloured railway signal lamps, concluded by stating—"That the success which has attended the exertions of the flint glass manufacturers, and enabled them to produce their brilliant specimens, will (he fears) make these humbler samples appear dull and uninteresting, until their cheapness and applicability show in what their advantage consists."

April 21.—Dr. ROGET, Secretary, V.P., in the Chair.

"*On the Manufacture of Shell Cameos.*" By Mr. GRAY. Six specimens of shells with the cameos cut upon them were exhibited.

The author commenced by stating that the ancients formed cameos by engraving figures in low relief on different kinds of silicious stones, and generally selected for that purpose those which had layers of different colours, so that the figures, or different parts of the same figures, were of divers colours. Such cameos are now made in Southern Europe and in France, where this art has lately been attempted to be revived; but the hardness of the materials require so much labour to be employed in their fabrication, that they are too expensive to come into general use.

Numerous attempts have been made to substitute various materials, such as porcelain and glass, for the ancient cameos, but their great inferiority has caused them to be neglected. The best, and now most used, substitutes are shells, several kinds of which afford the necessary difference of colour, and are, at the same time, soft enough to be worked with ease and hard enough to resist wear. The shells now used are those of the flesh-eating Univalve, which are peculiar as being formed of three layers of calcareous matter, each layer being a perpendicular lamina, placed side by side. The cameo cutter selects those shells which have the three layers composed of different colours, as they afford him the means of relieving his work; but the kinds now employed, and which experience has taught him are the best for his purpose, are, the Bull's Mouth, the Black Helmet, the Horned Helmet, and the Queen Conch—the two first are the best shells. After detailing the peculiarities of these shells, Mr. Gray proceeded to give an account of the progress of the art, which was confined to Rome for upwards of 40 years, and to Italy within the last 20 years, when an Italian commenced it in Paris, and now about 300 persons are employed in this branch of trade in that city. The number of shells used annually, thirty years ago, was about 300, the whole of which were sent from England, the value of each shell in Rome being thirty shillings. To show the increase of this trade, the number of shells used in France last year was nearly as follows:—

Bull's Mouth,	80,000,	at average price each,	1s. 8d.	..	£6,400
Black Helmet,	8,000,	„	5 0	..	1,800
Horned Helmet,	500,	„	2 6	..	60
Queen Conch,	12,000,	„	1 2½	..	700
	100,500 shells	.. ..	..	..	£8,960

The average value of the large cameos made in Paris is about six francs each, giving a sterling value of £32,000, and the value of the small cameos is about £8,000, giving a total value of the cameos produced in Paris, for the last year, of £40,000; while, in England, not more than six persons are employed in this trade.

The thanks of the meeting were presented to Mr. Gray for his communication, and to Mr. John Turner for two specimens, which he presented to the Society for its museum.

The second communication was "*On a means of rendering Sculptured Sandstone impervious to the effects of our changeable climate and humid atmosphere.*" By D. R. HAY, Esq.,

The author, after stating the nature and structure of the various sandstones, the causes which operate upon them and separate the particles, and the plans usually resorted to for preserving masons' work from the injurious action of the air, said he had found that the ordinary process of saturating the sandstone with linseed oil was ineffectual, and having occasionally used bees-wax as an ingredient in paint, and knowing from experience that it is impervious to the blanching or oxydising influences of the common atmosphere, he considered that if applied to sandstone, it would render it very durable. "I believe (observes Mr. Hay,) that it has been used by the ancients in securing their fresco paintings, by rubbing it upon them, and facilitating its absorption by the application of hot iron, and a similar application has been recommended in modern times in respect to sculptured marble; but such a process must be very uncertain as to its efficiency, in as much as the absorption must be very partial and unequal. The plan I would recommend is applicable to statues, vases, and all sculptured architectural decorations—namely, a trough of suitable capacity must be built of brick, with a furnace under it, and the trough filled with sand; place among the sand, at one end of the trough, a vessel made of tin or copper, and of the requisite capacity, into which put spirits of turpentine or naphtha and bees-wax, in the proportion of two or three pounds of the latter to a gallon of the former, according as the stone to be saturated is more or less porous. Keep the furnace burning until the sand has become sufficiently hot to dissolve the wax amongst the oleaginous or bituminous spirits in the tin or copper vessel. Place the stone to be saturated in the unoccupied part of the trough until it becomes of a temperature equal to that which has dissolved the wax, and if the capacity of the vessel admits, let the sculptured stone be immediately removed from the sand and dropped into the adjoining vessel, when, in a few seconds, it will absorb a sufficient quantity of the wax, held in solution by the spirits, to prevent the humidity of the atmosphere ever acting upon it."

An interesting discussion took place after the reading of the paper, in which Mr. Ray, Mr. Tennant, Mr. C. H. Smith, Mr. Crace, and several other scientific gentlemen, took part.

ROYAL INSTITUTE OF BRITISH ARCHITECTS.

April 12.—The followingpaper on the important public question of "*Ventilation*," and how far it may be rendered compulsory by legislative enactments, was read by Mr. J. Toynbee.

The author commenced by stating, that the result of the extended investigations, so long conducted by the medical profession, into the nature and treatment of disease, demonstrated that the great duty of every man was to carry out preventive measures. English people seemed to be but little aware of the large amount of disease by which man at the present time is afflicted; and yet the details in Lord Morpeth's recent speech, the returns of the Registrar-General, and statistics from various sources, showed that among them disease was the rule, and health was the exception. Let it be continually repeated, and never be forgotten, that one-fourth of the children born in England die before they reach their fifth year; and out of 49,089 people who died in London in the year 1846, 22,275 were carried off before they reached the fifteenth year; and only 2,241 died of old age, which Boerhaave stated to be the only disease natural to man. In addition to this, it must be known that, as a general rule, when the body is examined after death, whether of a child or adult, one or more organs is found in a state of disease: a fact which induced a physician to state that he looked upon every adult he met in the streets of London as a walking museum of morbid anatomy. If the causes of the 49,089 deaths in 1846 be examined, it will be found that the enormous proportion of 14,368 was from diseases of the organs of respiration. Now it has been shown that the great source of these diseases was the respiration of impure air. To suggest measures for the removal of this great evil, and to prevent some of the most distressing diseases to which mankind is subject, was his object in responding to the request of the Society that he would deliver the present address.

Mr. Toynbee then proceeded to consider the subject in its various bearings. In proof of the necessity for ventilation, he stated that it was of great importance that air should be continually in motion; for, like water, when stagnant, it became offensive and injurious. This was accounted for by the fact, that the air always contained a large quantity of animal and vegetable matter in the form of the ova of infusoria and the seeds of the lower vegetable organisms. But the act of respiration was the great cause of the deterioration of the air. The air in the lungs was exposed to 170,000,000 of cells, having a surface equal to thirty times that of the body; so that during respiration the air was deprived of oxygen, and became loaded with deadly carbonic acid gas, and was rendered totally unfit for a second respiration, being in reality no longer atmospheric air, but a poisonous gas. A second cause of the deterioration of the air is the combustion of lamps, gaslights, candles, &c. A single candle is nearly as injurious to the air as a human being: two fourteen-hole argand burners consumed as much air as eleven men. A third source of atmospheric impurity is the vapour, loaded with animal matter, given off from the lungs and the skin: each of these parts pours out an ounce of fluid every hour; so that, in a church containing 500 people, twelve gallons of noxious fluid are given off in two hours. A fourth source of bad air in towns is the large quantity of decomposing animal and vegetable matter left to give off its effluvia; and the difficulty there is in the renewal of the air in towns by means of the winds, on account of the vicious mode of their construction and their large size. In reference to the impurity of the air of London, Dr. Mantell states that various classes of infusoria, which he was in the habit of keeping alive in his house at Clapham, all died in London; and it is well known that scarcely any plants will live in London.

It was then stated that certain diseases were distinctly traceable to the absence of ventilation—namely, fever, consumption, scrofula, deafness, and that most fertile origin of numerous diseases, the common "cold." It was shown that 120,000 people in England and Wales are always slowly dying from consumption; that there is double the amount of this disease among in-door than there is among out-door labourers; that it was more frequent among women than among men; that in 1839, out of 33 milliners who died in London, 28 died of consumption.

Mr. Toynbee then declared that, up to the present time, the subject of ventilation had been entirely neglected in the construction of rooms, houses, towns, and cities; that the greatest injury had been inflicted upon mankind by this neglect; and, as the population increased, and towns became larger, the evil must become greater, unless remedies were at once carried into effect. Under these circumstances, until society should be sufficiently informed voluntarily to secure its well-being, it was the bounden duty of a government, the enlightened guide of its people, to suggest measures, and see them carried out, to prevent the large amount of misery that the absence of ventilation was producing. The important question, then, was—How far could Government interfere with advantage in enforcing plans of ventilation by legislative enactments?

Mr. Toynbee then submitted the following propositions, for the adoption of Government, to the consideration of the Institute:—

1. That no living, sleeping, or work room shall contain less than 144 superficial feet, or shall be less than 8 feet high.
2. That such room shall have one window, at least, opening at the top.
3. Also an open fireplace.
4. That in every living, sleeping, or work room erected in future, some method shall be adopted of allowing the foul air to escape from the upper part of the room.

He then pointed out the practicability of carrying out this provision, either by the introduction of Arnott's valve into the chimney, thousands of which were at this time in operation, and which might also be adapted to existing chimneys, without fear of smoke, by the addition of a simple contrivance which he described; or a distinct channel might be made for the purpose.

5. That every such room erected in future shall have some means of continually admitting fresh air.

6. In every public building in which gas is used, to insist upon the use of plans to carry off the products of combustion, and not to allow them to escape in a room. Various plans having this object are in operation in hundreds of shops, and may be seen in many shops in Regent-street; by their use not only are the goods in the shop saved from injury, but the health of the people is improved. He was happy to hear that in Covent Garden Theatre not a particle of the products of combustion from the gas was allowed to enter the theatre.

7. That all churches, schools, theatres, workshops, workhouses, and other public buildings, shall adopt such methods of ventilation as are approved by the Medical Officer of Health.

Mr. Toynbee pointed out how these desirable objects were to be effected, and showed that every house and room must be so arranged that it can be supplied with fresh air, to replace the vitiated air which has been removed. Prof. Hosking had carried out these plans in every part of his house; and until they were general, the diseases dependant upon the want of ventilation must be a scourge to society. He observed that in all the stables now erecting, admirable plans of ventilation were adopted. Having given this subject deliberate consideration, he had arrived at the above conclusions; in which, among many others, he was supported by Dr. Sutherland of Liverpool, and Dr. Guy of London—two of his many fellow-labourers in the public-health cause, whose enlightened intelligence was only equalled by their benevolence.

In conclusion, he stated that the various Health of Towns' Associations were at work heart and soul, instructing the masses of the people as to the best means of promoting their physical welfare—a labour in which every enlightened man should join. And he felt that if government would lend all the aid in its power towards carrying out sanitary measures, not only would an enormous amount of misery be saved, but an extent of happiness would be gained of which we had at present only a faint idea.

INSTITUTION OF CIVIL ENGINEERS.

March 23.—Sir J. Rennie, President, in the Chair.

A paper was read "*On the Ventilation of Mines.*" By Mr. J. Richardson. It dwells at some length on the present methods of ventilation and the objections to them, illustrating the positions by quotations from the best authorities on the subject; all of which went to show, that in spite of all the care and attention that had been given to the question, all the skill of the engineer, and the introduction of the safety-lamp in 1816, the loss of life had been greater since that period than it was in a corresponding period previous to its introduction. This must not be charged entirely to the lamp; for although it might have rendered men bolder, and induced them to trust too much to it in venturing into those parts of the mines which formerly would have been abandoned, still it must be borne in mind, that as the coal was got at greater depths and distances from the shafts, the ventilation becomes more difficult; and, from the greater number of persons employed in one mine, if an accident did occur, the loss of life was greater in proportion. The author then entered into calculations, showing that the dimensions of the "upcast shaft" should in all cases be increased, in proportion to the augmented volume of the air from the expansion of the higher temperature at which it leaves the mine after traversing all the passages; and if this were attended to, not only would the general ventilation be better, but in the event of an accident occurring by an explosion, or the derangement of some of the air-passages from falls of the roof, &c., an extra power could be applied, which would at any rate prevent a portion of the frightful loss of human life which now occurs. The conclusion drawn, however, was, that in almost all cases it was the culpable neglect of, and not the want of means of prevention, that caused the destruction of health, life, and property in the mining operations of the kingdom.

This opinion appeared to be participated in by all the speakers, in the discussion which ensued, and in which the interference of government by legislative enactments, with respect to methods of ventilation, was severely deprecated. It had become fashionable now, whenever a difficulty occurred, to recommend "legislative enactment" as an universal panacea; as if a committee of the house, or a body of commissioners, none of whom probably possessed any practical knowledge of the subject, could at once fall by inspiration upon the methods of prevention or cure which had so long eluded the careful investigation of scientific and practical men, whose time, talents, and fortunes, had been all devoted to the subject, from that great incentive to exertion—self-interest. When the example of foreign countries was quoted, it should be at the same time shown in how backward a state they were in engineering, in mining, in commerce, and, in fact, in everything with which the government interfered, as compared to the high state of perfection arrived at in this country, where there was nothing, for-

tunately, but competition to urge manufacturers and miners to bring their produce to market of the best quality and at the cheapest possible rate.

March 30, and *April* 13.—The discussion on the above paper was continued through both these meetings, to the exclusion of any other subjects. The methods of ventilation in use in the mining districts were fully described, and their peculiarities discussed. The causes of accident by explosions, and the consequent choke-damp, were inquired into; and the fitness of the attempted methods of prevention or cure was debated upon. The method of exhausting the air was contrasted with that of forcing it forward into levels by means of bellows and pipes. The system used in the north of placing a furnace at the bottom of the up-cast shaft was insisted upon as that best calculated for the extensive coal-mines of that district; while the method introduced by Mr. Gibbons in Staffordshire of exhausting the foul air, by air-heads cut in the lop of the coal, connected with a channel in the side of the shaft, terminating in a chimney on the surface, was received as a decided improvement upon the ordinary system in use in that coal-basin, where the extraordinary thickness of 30 feet of the vein of coal renders a peculiar plan indispensable. Various methods of attempting to carry off the foul air from the 'goof,' whether by additional shafts or by bore-holes, were proposed, and shown by mining experience to be totally impracticable, and calculated to be rather prejudicial than useful. The interference of Government was strongly insisted upon, and as decidedly objected to by those miners whose long experience and good judgment entitled their opinions to deference and consideration. It was shown that the foreign mines which were under the constant superintendence of Government engineers, far from being exempt from accident, were not only more liable to the effects of deficient ventilation, but that the actual loss of human life was greater than in England; and that if our mines were subject to the same annoying trammels, the price of fuel must be unduly raised, without any corresponding advantage, or any immunity from danger. There could be no objection on the part of the coal-owners to the formation of an association for regularly inspecting and reporting upon the states of the various mines, and the communication between the various districts of the methods found to succeed best under the attendant peculiar circumstances; but reasons were given why such a power should not be placed in the hands of Government officers.

The subject of safety-lamps and their uses was also discussed: Dr. Reid Clanny's first invention of the lamp in 1813, which necessarily failed from its cumbrous form and general inapplicability for working purposes, and the recent form he had adopted, combining portions of the other lamps in use, so as to show a bright light and yet be free from danger: the extraordinary coincidence of inventive thought between Sir Humphrey Davy and Mr. George Stephenson, the one acting upon purely chemical theory, and the other upon mechanical knowledge and practice, and yet both simultaneously producing lamps which were almost identical, and which still remained very generally in use under the names of the "Davy" and the "Geordie."

April 20.—"*On the Defects in the Principle and Construction of Fire-proof Buildings.*" By Mr. FAIRBAIRN, of Manchester. The paper commenced by insisting strongly on the danger of making use of cast iron beams of large span, without intermediate supports, unless the dimensions of the beams were very large, and pointing out the treacherous nature of a chrystalline metallic body, such as cast iron, when applied to support heavy weights in the construction of buildings. After some further remarks on the importance of a thorough knowledge of the laws which govern the use and application of cast iron as a material in building, under the various strains to which it may be subjected, the author proceeded to investigate the circumstances connected with the fall of Messrs. Gray's cotton mill at Manchester. This building was stated to be about 40 feet long, and 31 ft. 8 in. wide, and to consist of two storeys in height, containing the boilers below and the machinery above, over which, instead of a roof, was a water cistern, covering the whole extent of the building. The first floor was composed of large iron beams, of 31 ft. 8 in. span, without intermediate support; on these beams brick arches were turned, sustaining the whole weight of the upper part of the building. The author then demonstrated, that these large beams were totally inadequate to support the weight of the superincumbent mass, especially as the whole pressure was upon the centre of the beams, which were of a form ill calculated to bear the pressure; added to which, the wrought iron trussing was so badly applied, that the breaking strain was arrived at before the truss rods were brought into a state of tension. The consequence of this was, that one of the lower beams broke in the centre under a less weight than it had previously supported, both under preliminary trial, and when the cistern was fuller than at the time of the accident. The paper closed with some remarks on the delicate and invidious duty of reporting on such accidents as those in which the reputation of gentlemen of high professional acquirements may be involved; and the author expressed his reluctance in condemning the construction of the building in question.

In the discussion which ensued, it was argued that, if proper proportions of material had been observed, the accident ought not to have occurred. It appeared evident that the wrought iron truss rods had been so put on, that they allowed more than the breaking strain of the cast iron to be arrived at, before they came into operation. The instances of the trussed-beam bridges, extensively used by Mr. Stephenson, and other engineers, on railways, were quoted to show, that by a judicious employment of wrought iron trusses upon cast iron beams, large spans might be crossed with safety; and even, in some cases, where, from unseen defects in the metal, a beam had fractured, the brass rods had sufficed to support the structure, and enabled the traffic to be continued across the bridge until the repairs could be effected. In all cases a strength of not less than four to one should be employed, and for such uses as the iron beams of pumping engines, which were exposed to great vibration, and sudden shocks, from the sudden influx of steam below the piston, or the accidental breaking of a pump-rod, the proportions of seven or eight to one should be observed.

CHEMICAL SOCIETY.

March 15.—Lieut.-Col. P. YORKE in the Chair.

"*On the Decomposition of Water by Platinum and Black Oxide of Iron.*" By Dr. G. WILSON.—The interesting researches of Mr. Grove, on the decomposition of water by white-hot platinum, lately made public, have necessarily led to many conjectures concerning the cause of a phenomenon so extraordinary and unexpected. Certain remarkable peculiarities possessed by platinum, and in a less degree by others of the noble metals, have thrown some doubt on the powers of mere heat to effect the decomposition of a compound of such stability as water. The repetition of the experiments with other substances not open to the same objections is, however, a matter of great difficulty. While reflecting on the means of accomplishing this, the attention of the author was accidentally called to the evolution of small bubbles of gas from the fused globules of oxide of iron, produced by burning iron wire in oxygen gas, falling into water. In the hope that this might afford some clue to the phenomenon in question, arrangements were made for performing the experiment in such a manner that the gas evolved should be collected and preserved for examination. This was easily done by directing the fused globules of oxide, by means of an inclined plane of tin-plate, from the jar in which the wire was burned, under the edge of an inverted funnel entering a test-tube immersed in the water of the pneumatic trough. The quantities of gas disengaged by the globules were very unequal; some gave none at all. Generally, globules from the thickest wire produced most gas. The gas on examination, however, was discovered to be pure hydrogen, merely sullied by a trace of atmospheric air; and its origin was at once explained by an examination of the globules themselves, for very many of these latter were found to contain in their center a kernel of fused metallic iron, which had escaped oxidation when the wire was burned in the gas, and which in a highly heated state coming in contact with water occasioned the decomposition of a portion of the latter in the usual manner. The black oxide of iron does not appear to have the power of further abstracting the oxygen from water. This experiment is, therefore, valueless in elucidating the fact of the decomposition of water by heated platinum. It is probable, too, that the temperature of the melted globules of oxide of iron is really much inferior to that of platinum in the state in which it is employed in Grove's experiment, namely, just at the point of fusion.

Dr. Wilson then argues, that the decomposition of water by a white heat may be referable to the mechanical disruption of the particles in direct contact with the heating body, and not to the decomposing power of heat alone; as the statement that water can be produced by the same processes that disunite its elements would be tantamount to affirming that unlike effects may flow from the same cause, without any alteration in the qualities or conditions of the water.

REVIEWS.

Encyclopædia of Civil Engineering,—Historical, Theoretical, and Practical. By EDWARD CRESY. Royal 8vo. London: Longman and Co. 1847.

[SECOND NOTICE.]

We paused last month in our notice of Mr. Cresy's book, at the interesting subject of engineering in England, of which we only gave one extract, that relating to New London Bridge.

Docks deservedly occupy a considerable space in Mr. Cresy's book, for they are works in which the English have peculiarly distinguished themselves. Indeed, the tidal phenomena of the English coasts have had as much to do with the extension of this class of work as any commercial demand, for whereas in the coasts of Holland and the United States, and in many parts of the world, the rise of tide is little or nothing, on the English coasts it is in all places considerable, and particularly favourable for all kinds of docking operations. In France docks and basins are chiefly for naval purposes, and in the Mediterranean there are no tides, so that England stands almost alone in a class of works which demand great scientific resources, and which are frequently on a scale of colossal grandeur.

Mr. Cresy in taking up this subject prefaces it by a description of the natural features of each river and harbour, which is essential to a proper appreciation of the engineering works. In the Thames, Mr. Cresy states that there are not only the commercial docks in the Lon-

don district, but Government docks at Deptford, Greenwich and Woolwich, which, with the numerous small basins belonging to ship-builders and merchants, present an accumulation of works of this kind, not elsewhere to be met with, though the area of the Liverpool docks is much more considerable. Another very numerous class of works in the Thames are the landing piers, some on a considerable scale. Mr. Cresy notices the Gravesend piers, but not that at South-end.

In adverting to the east coasts of the island, the author describes some of those harbours which have given so much trouble to the engineer, on account of their shifting channels, and the silting up of their basins. Of Wells harbour he gives a very curious illustration.

It may very well be conceived how well a review of the harbours and ports of England is calculated to bring under the notice of the professional reader a number of works which, however well known in their respective localities, are not familiar to distant engineers, and the particular value of a work of this kind is, that in this way it enlarges the sphere of professional observation, and in so far of professional experience. This is particularly desirable in the present state of engineering, when an engineer from the south may be sent to execute hydraulic works in the north, or an engineer from the east be despatched to the west, and so forth. Were this experience more diffused, we should not see cases, as we have recently done, of steep stone walls being run up as sea walls, under the idea that with strength of material, good masonry, and plenty of concrete, the engineer had done all that was required of him, and that the sea would not tumble it down.

In the present day, railway engineering and surveying employ many members of the profession, whose chief experience is in connection with earthworks, so that when they come to be employed either generally in hydraulic engineering, or are required to execute works of that class in the construction of a railway, they are very apt to find the want of a more extended experience. Hydraulic engineering is so different in its character, and in its application—it varies so much in its forms, according to the localities in which it is practised, that it is well calculated to bewilder the uninitiated or the inattentive. If an engineer runs up a railway embankment, or a viaduct, all he has to care about is that it be made of sufficient material, and with sufficient workmanship, and he has no need to think about it again, for it will stand for ever. Not so if he puts a pier in the sea, or builds a quay wall; in such case, it will require something more than bricks and mortar to secure the efficiency of the work, for though he may lay down what he considers a very strong and sufficient work, it may be that the stronger and the more rigid his materials, the more certainty of its being swept out to sea. Hence the very serious complaints that we hear of the unsatisfactory nature of so many of our hydraulic works; for if in our railway works we are as it were spotless, and without blame, our harbours are perpetual sources of annoyance and complaint. We are therefore particularly glad to see a work like Mr. Cresy's, which carries out on a large scale, and in a comprehensive manner a design, which in the pages of the Journal we have only been able to do piecemeal, and in a very imperfect manner.

Mr. Cresy gives plans of most of the docks in the Thames, with sections of the entrance locks, and also describes the docks at Sheerness. The Hull Docks are given in great detail; Spurn Point affords the author an opportunity of describing the old lighthouse, built by John Smeaton. Hartlepool Docks are also described, and a plan is given.

Many of the Scotch harbours have of late years been improved at a great expense, and the present work contains plans of most of them. Among them we may notice Leith and Dundee. There is also an account and engravings of the Slip at Dundee. Gourdron Harbour, by Telford, is a specimen of a small fishing harbour among rocks. Aberdeen Harbour is accompanied by a plan and engravings, representing the masonry works. Peterhead is another specimen of a harbour constructed among the rocks, and which was partly executed by Smeaton. Frazerburgh and Burghhead are also represented in plans.

Findhorn, Avoch Harbour, Cullen, Fortrose, Mahomac, Kirkwall, Kyle, Rhea, Tabermory, East Tarbet, Small Isles Pier, Feoline, Corran, Androssan, are some of a multitude of works constructed on the Scotch coasts. Of all those named, plans and other engravings are given in the present book. Of the works in the Clyde we do not however notice such ample details.

Liverpool, of course, gives an opportunity for lengthened description, but in this case also we think Mr. Cresy's details might have been given fuller with much advantage. His subject is however so extensive, his space limited, and the amount of information he has given so great, that we cannot quarrel with him even about Liverpool.

Holyhead Harbour is described, and we may observe that this encyclopædia will be found a work of easy reference for plans of docks and harbours.

St. Ive's Harbour and Plymouth are the chief illustrations on the West coast, but the Breakwater and the Eddystone Lighthouse come in for an ample share of description. Many of the courses of the lighthouse are shown, so as to exhibit the manner in which the work was tied in by dovetailed and jointed masonry.

Dover and Ramsgate are the plans given on the South-east coast, with a copious account of the works. The Bay of Dublin, with Kingstown and Howth, serve for examples of Irish works. Jersey Harbour and St. Aubin's close the list of harbours.

Among the lighthouses, of which numerous examples are given, we notice the omission of cast iron lighthouses and screw-pile lighthouses, which are recent additions to the resources of this department of engineering.

As exemplifications of ancient art, Mr. Cresy gives some of the old gates and castles dispersed throughout the country, and thence he proceeds to bridges.

We are not quite disposed to concur in his dictum that no bridges of any consequence in this country were erected previous to the Roman invasion, for we think he has given evidence to the contrary in the case of Old London Bridge. Anciently, bridges were erected of timber in preference to stone, because timber was the material at hand, the cheapest and the most available, as it is used for the same reasons at the present day in many parts of America and Europe. Mr. Cresy gives a history of bridges in England, of which we shall avail ourselves of some extracts.

"*Bridges.*—We have no evidence of any bridges of consequence being erected previous to the Norman conquest, and the names of our principal towns on the banks of rivers, having the word ford attached to them, seems to confirm the opinion that none existed. Following the course of the Watling Street, or great Roman road over the Medway, we meet with Aylesford; over the Darent, Dartford; the Cray, Crayford; the Ravensbourne, Deepford; and so with most other rivers in England. The capital in all probability would first have a bridge in preference to a ferry, which is noticed over the Thames. We have an account of a timber bridge constructed by Etheldred in 1002, which lasted many years, and also of another built in 1165.

The first stone bridge was begun in 1176, by the celebrated Peter of Colechurch, who continued the work during the reigns of Henry II., Richard I., until the second year of the reign of King John, when he died, and was buried in the crypt of the chapel erected over the centre pier.

It appears to have been the custom with the society called the Brothers of the Bridge, when any member died during the superintendence of any important work, to have his remains entombed within the structure; and as all great bridges were provided with a chapel and crypt, every means was afforded for the performance of the annual rites that were usually instituted. The great bridge at Avignon, when built by S. Benezet, or Johannes Benedictus, the first brother and founder of the order, had such a chapel, where he was buried in 1222.

This stone bridge was 926 feet in length, 15 feet in width, and 60 feet in height above the level of the water. It contained a drawbridge, and nineteen broad pointed arches, with massive piers, varying in solidity from 25 to 34 feet, raised upon strong elm piles, covered with thick planks, bolted together.

Timber bridges of very simple construction were long made use of over the wide rivers in England, but no skill was exhibited in the framing, nor any further mechanical principle than that of strength; trees merely squared, were laid side by side, at right angles with the stream, supported on a single row of perpendicular piles, or several rows parallel to each other, capped and cross braced, and sometimes planked over to the height that the water rose, the space between being filled in with stones. The roadway was cross-planked, covered with chalk and gravel, and frequently required repair, in consequence of the air not being admitted to the upper side of the planking.

It would be an endless task to enumerate all the bridges erected in England by the freemasons of the middle ages; many were built, as has been observed in the same manner as the vaults of the chapter houses and cathedral churches; after the piers were carried above the level of the stream, ribs of stone spanned the opening from one pier to the other, and supported a rubble construction laid above them, an arrangement combining both economy and convenience. In subsequent instances we see one or more rings of voussoirs spanning a river, upon which slabs of stone are laid, and the bridge completed; but it must be borne in mind that such ribs only serve the purpose of centres, and cannot have the strength of our modern bridges, where a wedge-like form is given to every portion of the stone.

After the reign of Henry VIII. bridge-building underwent a considerable change; timber constructions again became very common, and some of the principal rivers were crossed by them. In the year 1636, Inigo Jones erected a bridge at Llanwast in Denbighshire, after the method practised in Italy, which was the model for some of the succeeding structures.

It was formed of three segmental arches, the middle spanning 58 feet, with a versed sine of 17, and the breadth of the soffite of the arch 14 feet. The depth of the voussoirs, measured on the face, was 18 inches, the piers

were 10 feet in thickness. The pointed arch was no longer used, and the defences of towers and gateways were unnecessary: the passage was made more convenient, and the roadway approached a horizontal line, in consequence of the substitution of vehicles for the pack-horse for the transit of merchandise.

At the commencement of the eighteenth century we find evidences of an attempt to improve the bridges throughout England, but there is no account of any principles by which the engineer could be directed, nor are there any names upon record to whom such constructions were particularly entrusted; what had been done in Italy does not seem to have found many imitators here, and though Newton had discovered the principles upon which mechanical science was based, it was long before the equilibrium of the arch occupied the consideration of practical men. Dr. Hooke had, however, drawn attention to the figure which a heavy chain or rope assumes when suspended at the two ends, and shown the properties of the *catenaria*; but it was not then applied to the construction of bridges."

The exemplifications of the larger bridges of modern times will be found very useful, as they include details of every important work. In most cases the construction of the coffer-dams, centering and auxiliary works is fully shown. Copious extracts are also given from the specifications, particularly valuable in illustration of the workmanship. The railway bridges give so many examples that a very good instance is shown of the enlarged field of practice in the present day. This affords Mr. Cresy the opportunity of describing skew bridges.

Cast iron bridges form a section of themselves, and are followed by suspension bridges, both of which are amply illustrated.

The Ancient World, or Picturesque Sketches of Creation. By D. T. ANSTED, M.A., F.R.S., F.G.S., Professor of Geology in King's College. London: Van Voorst, 1847; 8vo. pp. 408; woodcuts.

Some years ago, the readers of French literature were entertained by an abridged version in that language of a work bearing the truly oriental rhyming title, "Takhlis ulabriz fi talkhisi Bariz"—*The purification of gold in the description of Paris.* The author was a young student, the Sheikh Refaa, sent to France by the Pasha of Egypt to complete his education. The original work was published at the Arabic press of Boulaq, in Egypt.

The Sheikh Refaa, though a Mussulman, resided in Paris, for the purpose of learning the philosophy of the Christians. Impressed with the wonders of European civilisation and the magnificence of the city in which his education was completed, he became anxious to overcome the prejudices entertained by his countrymen against the arts, sciences, and institutions of the Franks. The chief difficulty which he experienced was in reconciling the Newtonian system of astronomy with that of the Koran. He remarks that the former is altogether irreconcileable with the account given in the books accounted sacred by the Christian as well as the Koran; and that the orthodox of both creeds will have to exercise great caution in reading the modern scientific treatises; for they are written with such logical precision and mathematical accuracy, that nothing but the strongest faith is proof against their conclusions.

Here was the testimony of a sensible man, whose reason drew him one way and his prejudices another. This state of incertitude was not, however, peculiar to him. A great continental mathematician thought it necessary to preface his investigations with an apology for the discrepancies which did violence to his faith, and made an excuse which meant, as far as any meaning can be attached to it, that he did not see any way of escaping the conclusions of modern science; but if he *must* assent to them, it was against his will. The thunders of the Popes (who, until the present, have always preferred dogmas to proofs) have frequently produced recantations, expressed in a similar spirit.

A numerous and zealous sect existed in our own country not many years since, who denounced the doctrines of Newton as blasphemous, and attributed to the credence they had obtained the temporal calamities of the country. Many half-taught enthusiasts have attempted refutations of the *Principia*,—and with perfect success, if it be a sufficient criterion of success that no one has replied to them. Even within the last twelvemonths, the Quixotic attempt to enter the lists with Newton, Lagrange, and Llaplace, has been renewed by a Mr. Isaac Frost: whose chivalry we should have deemed somewhat too late for the times, had we not read the reviews of his essay. These convinced us of that which otherwise we should have deemed impossible—that Mr. Frost might yet find disciples. It is difficult to decide whether he or his reviewers display the most ludicrous ignorance of the subject with which they imagine themselves acquainted. Why should Mr. Frost despair?—Johanna Southcote was eminently successful in her day, and even now has followers.

Geology is in the same predicament as astronomy—it is unanswerable, but heterodox. It is true, that various disputants have appeared, and among them those of whose education better results might have been anticipated. For example, the Dean of York published long letters in the *Times*, in which he demolished geology to his own perfect satisfaction. Had he kept to the question of heterodoxy, he would have been inexpugnable—*cuique in suâ arte credendum est.* But when he descended from the mountain to the plain,—when he attempted to discuss mechanical principles, he admitted the rights of human reasoning and put himself upon a level with his opponents. This was the fatal error of his tactics. He illustrated the motion of planets by the whirling of a pail of water—it was but too evident that he had tried the experiment, and been made giddy by it. He treated of the congelation of igneous vapours—and in language which plainly indicated that he had incautiously exposed himself to their fumes. The good doctor's zeal was worthy of a better cause. An excellent theological library was turned into a bad laboratory, and the Schoolmen and the Fathers were displaced by crucibles and the three mechanical powers.

The philosophers of this school seem to forget that the simple denial of the theories of modern geology is not sufficient; if they reject these, they must substitute others. A vast number of natural appearances have been recorded—the skeletons, exuviæ, and vestiges of by-gone races of animals,—the traces of violent disturbances of the materials of the earth,—and those ancient records to which the Pyramids are ephemeral gossip, are written in so large and legible characters that it seems impossible to dispute their meaning. If, then, the interpretation given by geologists be rejected, have they not a right to demand that a better be supplied? You dispute—say they—our explanation of the facts; the facts themselves cannot be disputed;—how then do *you* explain them?

To this question no reply has been even attempted. But lest the student of geology should feel himself in the same anomolous position as the Sheikh Refaa with regard to astronomy, let him be assured that neither science need, in reality, offend his scruples. The subject has been so hotly debated that, at the risk of appearing to discuss topics not strictly within our province, we will endeavour to show how the discrepancies in question may be reconciled without resorting to scepticism. The view which we take may be best explained by an illustration. Suppose that an eminent writer on the laws of commerce and navigation were in the course of his writings to make incidentally a mistake respecting the construction of steamers or sailing vessels;—would that mistake invalidate the whole of his treatise? A wise reader would discriminate between the two kinds of knowledge, and allow that his author might be thoroughly versed in political and financial economy, and yet be ignorant of engineering and shipbuilding. In the same manner, when David speaks of the "round world" being made "so fast that it cannot be moved," are his aspirations of thanksgiving the less worthy of reverence because he erred in thinking the world a flat circle instead of a spheroid, and was ignorant that the spot where he indited was moving with a velocity which the swiftest arrow never attained?

What would be thought of the wisdom of a judge who opposed trial by jury because the Jews had no such institution,—who adopted the severe penal code of the forty years' sojourners in the wilderness,—and passed sentence of death where subsequent experience has proved a milder punishment to be more efficacious? Could an English mariner adopt the rules of seamanship practised when Paul navigated the Archipelago;—or a farmer adhere to the Levitical rules for fallow lands;—or an architect imitate the construction of the temple of Solomon? Must modern physicians adopt Hezekiah's plaister of figs, or astronomers prefer his sun-dial to their own chronometers? Must we disbelieve in the existence of America, and suppose Gades the extremity of the world, because the geographical knowledge of the inspired writers was imperfect? Must England imitate "the freest nation on earth," (the United States) and sanction slavery because it is recognized in the Pentateuch? Such, indeed, is our absurd position, if we suppose that their commission extended to purely secular objects; if, in other words (for the whole of the recent confusion on the subject may be referred to this) the same respect be demanded for their *incidental* remarks as for their primary doctrines.

Can anything be more unreasonable than this? Men of every creed admit that when the Queen appoints Royal Commissioners for a particular investigation, their authority does not extend beyond the objects of their commission: and yet those who carry out the analogy in matters of higher import, are reviled for impiety, blasphemy, and scepticism!

One more observation on the question as it affects geology, and we dismiss the subject. The Mosaic account of the creation, like that

of Hesiod, was in all probability nothing more than a record of the belief generally prevailing among the contemporaries of the writer. At all events, there is not one word in the accounts which assumes to them a higher character. But however this may be, one thing is certain—that the Mosaic account would be inconsistent with itself if interpreted literally. The sun was not created till the third "day;" therefore, during the previous days, there were no means of marking the period of twenty-four hours—the interval between sunrise and sunrise, or sunset and sunset. We are, therefore, forced to a conclusion which no sophistry can elude,—that here, as elsewhere in Hebrew, the day is an indefinite period or epoch. Lastly, be it remembered, that if the Biblical student reject the conclusions of geology, he must do that for which in many cases he is not prepared—extend his scruples to astronomy also: both sciences are equally at variance with the Mosaic cosmogony.

Of Professor Ansted's *Ancient World* the established reputation of the author renders a critical examination unnecessary. The principal object of this work is to present to the uninitiated reader a series of pictures or descriptive representations of the appearance of the earth at different periods of its transition, from the chaotic condition, to that in which it became duly prepared for the habitation of man. With this object in view, Professor Ansted has generally confined himself to the statement of the results of observation, and has frequently deemed it unnecessary to detail the steps leading to those results. In a work intended, not to *prove* the science of geology, but simply to lay before those who are about entering upon its study, a general description (an outline chart, as it were) of the route they are to take, the minuteness of logical induction would be tedious and unnecessary.

The great merit of the work is its fidelity and vividness of description. The wonderful story of creation is not told as an old story; but the reader is put in the position of an actual observer of the phenomena, and is transported to the very scene and time of their occurrence. This method of *realising* the results of science is beneficial to the student, by the strong impression it makes upon his memory; it is profitable, also, to the more advanced in knowledge. The advantage of clearly tracing out the results and actual applications of science can only be duly estimated by those who have experienced the benefit of this kind of study. The remark applies to both the inductive and exact sciences. The philosopher who contents himself with understanding a particular "law," and the method of proving it, is content with knowing half a subject. He must develope the consequences of the law under all the variations of circumstances to which it can be applied—in other words, he must translate it into familiar, untechnical language—before he can be said to have apprehended the whole of its meaning.

Although the work before us displays geology in a new light—not as a description of the fossils of a museum, but as the natural history of animated beings,—although the dust of ages is wiped away from these records of the pre-adamite world, we are not to suppose that the author has given license to his imagination at the expense of scientific accuracy. He exhibits the ancient inhabitants of the earth as living creatures, exhibits their form and size, their habits and manner of living, their relations to coeval animals, their means of securing their prey, and of resisting or eluding hostile attacks,—but nothing is represented or described without authority. These Sketches of Creation are not fanciful sketches. On the contrary, they are drawn with scrupulous adherence to known facts, and in many cases, are even left somewhat obscure, because more precise representations of the subjects could not be given without the hazard, at least, of inaccuracy.

The opponents of geology are uniformly ignorant of its facts; but those whose prejudices are not too strong, nor intellects too weak, to allow them to learn truth, may acquire the rudiments of the science pleasantly enough from the present treatise. It is sufficiently precise and methodical for a lecture room, and yet far more entertaining than nine-tenths of the new novels. The author has practised an innocent artifice—a pious fraud—upon his readers. While they seek mere amusement, they are being instructed. Correctives of error and wholesome truths are administered as pleasantly, and swallowed as unsuspectingly, as the dosed cakes given to fractious children, who resist medicine in its more palpable form—the unconscious victims fancy they are indulged, while in reality they are being physicked.

It would have perhaps added somewhat to the interest of Professor Ansted's work to the general reader, if the accounts of fossils had been less detailed, and the information respecting the changes which have taken place in the strata composing the earth's crust more ample. When, however, we consider the knowledge which has been wonderfully, but securely, attained from the fragmentary remains of ancient animals, we can scarcely feel surprise that one of the most zealous students of palæontology should desire to confine attention to its results. A striking instance does this new and wonderful study present of the value of accumulated knowledge. By co-operation and unanimity of purpose, by the willingness of each labourer to pursue the task where his predecessor left off, the steep rugged road of knowledge has been made so smooth, and carried so far, that the labours of individuals are almost insignificant compared with the whole work accomplished.

It is no ordinary contemplation to see creatures that perished ages before history—*our* history—began, reanimated by this Promethean flame of science which exhibits them moving freely on the face of the earth that has so long hidden their remains. "Can these dry bones live!" For uncounted cycles of time, their sepulture has been undisturbed. Earthquake, flood, tempest, and volcano's fire have passed over, yet not effaced, them. The rough hands of the miner and the delver reveal these sacred hieroglyphics, and the patient researches of men of science expound them. The one exhibit the world as the repository of the skeletons of nations: the other penetrate the mysteries of the great charnel-house, and unfold one page more of that blazing scroll which records the benificence and power manifested in the works of creation. The dry bones are dry no more: reclothed with flesh, renewed with life and strength, they add yet another testimony to the potency of that voice which is "mighty in operation," and the Vision of the Valley is fulfilled and interpreted anew.

Engineering Field-Notes of Parish and Railway Surveying and Levelling. By H. J. Castle. London: Simpkin and Co., 1847.

This work, which we recently noticed, has already attained a second edition, and which has been improved by adopting some of the suggestions we gave in our review—one of them, adding sketches to the field-book.

The Baronial and Ecclesiastical Antiquities of Scotland Illustrated. By A. W. Billings and W. Burn. Part I. Quarterly. Edinburgh: Blackwood and Sons.

If we may judge of the example before us, this work promises to be one of great interest to the architect and the antiquarian. The present part is illustrated by four well executed engravings of Glasgow Cathedral, which we see are from the drawings of Mr. Billings, a gentleman well known to the Profession for his zeal in promoting works on Gothic architecture.

MR. WARNER'S INVENTION.—THE BALLOON "LONG RANGE."

Extracts from the Journal of the Proceedings of the Committee (Captain Chads, R.N., and Lt.-Col. Chalmer, R.A.) *appointed to inquire into* Capt. Warner's *Inventions, by the Board of Ordnance.*

13th August, 1846.—Capt. Chads and Lt.-Col Chalmer repaired to the official residence of the first lord of the Treasury, where they met Lord J. Russell, the Marquis of Anglesey, Viscount Ingestre, and Capt. Warner, to settle preliminary instructions.

"Much conversation took place on the subject of the course of experiments necessary to test the practicability of the 'Long Range.' Capt. Warner stated that he found it impossible to come to a proper understanding without he was permitted to disclose a part of his secret, which he proposed to do, and which was assented to by the committee, under the sanction and caution contained in paragraph 8* of the master-general's instructions.

"Capt. Warner then produced five drawings, showing that his mode of operation is by means of an air-balloon.

"The committee submitted to Capt. Warner the following experiment, requesting from him an estimate of the cost of carrying it out, viz., that he should construct a balloon capable of carrying 45 projectiles; that he should deposit 15 of these at 4 miles; 15 at 4½ miles; and the remaining 15 at 5 miles." [At a subsequent meeting, held 10th Sept., it was agreed "that the number of projectiles should be 30, instead of 45, and that each projectile should weigh at least 10lb., and that 10 should be substituted for 15 at the distances agreed upon; and it was further agreed upon that Capt. Warner should be in communication with Lt-Col. Chalmer, with the view of selecting a spot suitable for the experiment, and that he will endeavour to be ready in all respects by the first week in October."]

* "The committee will very fully explain to Capt. Warner that it is not desired that he should reveal his secret, or any part thereof; but if in the course of proceedings he should be desirous of doing so, that it must be in writing, and he must clearly understand that this will not establish any claim on the government for remuneration."

15th August.—Capt. Warner delivered in his estimate for the expenses of the trial proposed to be made to test his "Long Range," amounting to £1300. On the 12th Sept. this amount was advanced by the Treasury and paid into Capt. Warner's bankers.

28th Sept. to 9th Nov., the Journal shows was occupied by Capt. Warner in seeking a suitable situation for the experiments.

"9th Nov.—Lt.-col. Chalmer proceeded to Stafford, having previously received notice from Capt. Warner that a suitable situation for the experiment would be found on Carnock Chase.

"10th Nov.—Lord Ingestre met Lt.-col. Chalmer at Silkmore, near Stafford, took him in his gig to Haywood-park, and was kind enough to lend him a horse for the purpose of surveying the Chase; they rode over this for some hours; Capt. Warner had previously seen the ground, and approved of it, and had selected a place at Haywood-park suitable in all respects for his operations; and as there was a clear uninterrupted space of many miles, Lt.-col. Chalmer consented to the situation for trying the experiment, and, on his return to London, reported accordingly to the Marquis of Anglesey, to whom the Chase belonged, who most readily gave his consent, directing at the same time that every assistance should be given by his keepers; and Capt. Warner was informed to this effect, and requested to proceed with his preparations for the experiment with as much haste as possible, on account of the advanced season of the year.

"20th Nov.—Letter from Lord Ingestre, stating that everything was progressing as fast as possible, and expressing hopes that all would be ready for Monday (23rd), and requesting Capt. Chads and Lt.-col. Chalmer to sleep at Birmingham on Sunday night (22nd), where they should find a letter detailing the movements for the next day.

"22nd Nov.—Capt. Chads and Lt.-col. Chalmer left London by the mail train at 8h. 45m. for Birmingham, where they found a letter from Lord Ingestre, stating that the experiment would not take place the following day.

"23 Nov.—Lt.-col. Chalmer and Capt. Chads took a chaise from Stafford to Haywood-park; the day was very wet, foggy, and unfavourable, so that little was to be seen; they went on to Ingestre, having received the honour of an invitation from Earl Talbot.

"24th Nov.—Lord Ingestre drove Capt. Chads and Lt.-col. Chalmer over to Haywood-park-farm, where Capt. Warner was located, in a wood near which he was preparing his machinery for the experiment. Lord Ingestre went out to seek Capt. Warner, who came to the farm-house by another route. Lord Anglesey rode up to the farm about one o'clock, expecting to find us all there, but Lord Ingestre was not present.

"Captain Warner was asked when he could act? he replied that he must have a northerly wind to give him the necessary range; that he would act from the place on which his machinery now was, as it was not necessary that he should see the spot he was to act against. It was mentioned to Capt. Warner, that we ought to see that all was fair, and that no one went up in the balloon. He objected to our seeing his operations, and, as to any persons going up in the balloon, he stated 'that would be impossible,' as, when the last flight of missiles took place, the balloon would be burnt; that he should drop many more balls than specified as the balloon went along the range, some of them having small flags that they might be the more readily found and seen. One of the balls he showed us, made of copper filled with lead, about the size of a 12 lb. shot.

"The Fair Oak, a large old tree, about three miles distant from the station at Haywood-park, in a S.S.W. direction, was fixed upon as the mark for the flight of shot, and there Capt. Chads was to be stationed, and Lt.-col. Chalmer was to be near the machine. It was pointed out to Capt Warner that he should place the same confidence in us as in those who were assisting him; further, we did not wish to pry into his secret.

"Lord Anglesey met Lord Ingestre after the meeting, and told him what had passed.

"25th Nov.—The following arrangement was agreed upon between Lord Ingestre and Capt. Warner, on one part, and Capt. Chads and Lt.-col Chalmer on the other:—

"1. Capt. Warner to send over to Lord Anglesey as early as possible on the morning of the day on which he means to operate.—2. The time of operation to be as near noon as convenient.—3. A pilot to be sent up half-an-hour precisely, and another five minutes before the operation commences.—4. Capt. Chads will place himself as near the Fair Oak as he judges convenient.—5. Lt.-col. Chalmer will be at the starting point.—6. Lord Anglesey will place himself where he thinks proper.

"Capt. Chad and Lt.-col. Chalmer left Ingestre Hall for Beau Desert, having received the honour of an invitation from the Marquis of Anglesey.

"27th Nov.—Capt. Chads and Lt.-col. Chalmer addressed a letter to Capt. Warner, representing to him the inconvenience the detention occasioned them, and pressing that he should remove to a site from whence he would have greater chance of operating; or that he would inflate the balloon at its present station, and remove it so to a position proper for its ascent, so as to command the necessary direction of range. Mr. Warner replied, that if the wind stood as it then was, he would be able to operate in the course of the next day, and that he would send over to Beau Desert early in the morning to let us know whether he would be able or not.

"28th Nov.—The morning appearing fine, with the wind at north, gave us reasonable hopes that the long-expected experiment would now take place. Lt.-col. Chalmer left Beau Desert at half-past ten o'clock, A.M., for Haywood-park; when within a mile of that position he fell in with a messenger bearing a letter from Lord Ingestre to the Marquis of Anglesey, dated Haywood-park, Nov. 28th, 11 A.M., requesting that Capt. Chads and Lt.-col. Chalmer might be at the four cross roads on the Chase at two o'clock, 'everything being ready.'

"Lt.-col. Chalmer went on to Haywood-park, where he met Capt. Warner, and shortly afterwards Lord Ingestre, who both stated that the experiment would take place at three o'clock.

"Capt. Warner stated to Lt.-col. Chalmer that he had despatched a pilot balloon at 11 o'clock A.M., and that its course was as desired, and that he considered that the whole distance of five miles and the three deliveries of shot would be accomplished within 10 minutes.

"Lord Ingestre stated to Lt.-col. Chalmer that he was deputed by Capt. Warner to convey to him that it was objected to by Capt. Warner's friends (or committee) that he (Lt.-col. Chalmer) should be stationed at or near the balloon, as had been arranged.

"Capt. Warner took Lt.-col. Chalmer into another room, and there showed him the frame, and the method of suspending the shells, and expressed his regret that he could not exhibit more of his plan, or show him the balloon. As Lt.-col. Chalmer could not be permitted to take up the position assigned to him, he preferred returning to the open Chase, and joining Lord Anglesey there, to taking up a position at the gate of Haywood-park, as proposed to him by Capt. Warner.

"Lt.-col. Chalmer left Haywood-park at half-past two o'clock; Lord Ingestre left about a quarter of an hour afterwasds, passed Lt.-col. Chalmer on the road, and conveyed to Lord Anglesey and Capt. Chads the intelligence that the experiment could not begin till half-past three o'clock, and that a pilot balloon would be despatched ten minutes before the large one as a signal.

"Lord Ingestre and Capt. Chads took up their station at the Fair Oak, Lord Anglesey and Lt.-col. Chalmer at the cross roads to the eastward of the Fair Oak, and about a quarter of a mile nearer Haywood-park. Half-past three o'clock had arrived, and all parties waited in anxious expectation, directing their attention towards Haywood-park. At a quarter-past four o'clock, Lord Anglesey left the ground. The sun had set, it was growing dusk, and we gave up hopes of the experiment taking place, when at 20 minutes after four o'clock, Lt.-col. Chalmer perceived the balloon at some height coming from Haywood-park, and, as he thought, directly towards him. He called out loudly, which soon brought Lord Anglesey back to his old position. The balloon continued to approach, its elevation increasing considerably, and it continued visible to Lord Anglesey and Col. Chalmer for more than twenty minutes, taking a more easterly direction (many points wide of the Fair Oak), till it disappeared, from its great elevation. Neither Lord Anglesey or Lt.-col. Chalmer could distinguish anything to fall from the balloon, and they had doubts whether it was the pilot or the large balloon they had seen.

"Lord Ingestre and Capt. Chads had given up all hopes of seeing the balloon that evening, when their attention was called to it by the shouting of Lt.-col. Chalmer; it was at a considerable height, drawing on towards south-east, and rising quickly, till lost sight of by them. When moving on to join Lord Anglesey, they heard a sudden rushing noise to the eastward of them, but nothing was perceptible; and Lord Ingestre and Capt. Chads had also their doubts as to whether the balloon seen was the one containing the shot or only the pilot one.

"Capt. Chads and Lord Ingestre rode to Haywood-park, and there ascertained that it was the balloon with the shot that had been seen; and it being now late, and too dark to make search for the projectiles (or shot), the party left the Chase and returned home.

"29th Nov.—Capt. Chads and Lt.-col. Chalmer left Beau Desert at nine o'clock for Haywood-park, to meet Lord Ingestre and Capt. Warner, for the purpose of ascertaining where the shot had fallen the preceding evening; on their way thither they examined the ground to the eastward of the cross roads, without finding anything. Near the farm-house they met Lord Anglesey's keeper, who had been present at, and assisting Capt. Warner in his experiments; he told them that the balloon had been found last evening half a mile short of the village of Rugeley, which is about three miles distant from Haywood-park, and 1½ to 2 miles to the eastward of the Fair Oak (the object marked out).

"Lord Ingestre and Capt. Warner joined at Haywood-park-farm, and the whole party rode in the direction Capt. Warner pointed out as the most probable line for finding the shot, and after three hours' search, without success, it was abandoned. During a part of this time, Lt.-col. Chalmer separated from the party, and rode over the ground a second time, to the eastward of the position he had occupied during the experiment, but found no shot.

"At about four o'clock, Lord Ingestre proposed to drive Capt. Chads and Lt.-col. Chalmer in his chaise, through Rugeley, on their way back to Beau Desert, and having ascertained that the balloon had been conveyed to the Bell tavern, they stopped there to obtain information.

"On going into the town, they were met by a person whom Lord Ingestre appeared to know, and who informed him that the balloon had fallen about half a mile short of Rugeley the preceding evening (near the four cottages); that some labourers had got hold of it, and had given it up to a gentleman for a guinea: that he (the person who addressed Lord Ingestre) had claimed it as his own, on which disputes arose about it; and some alarm had spread over the village, as some powder, and nine of the shot, were found attached to the balloon, and there was also a suspicion that some one had gone up with the balloon, and had been killed. The police

were sent for to take charge of the balloon, &c., and directed by a magistrate to retain it.

"Lord Ingestre told the police that he was a magistrate, and that there was nothing improper intended, and to give the balloon up to the person claiming it, and that he (Lord I.) would be responsible for their so doing; to which they assented. This person then went with Lord Ingestre and Capt. Chads to a stable; showed them the balloon, and explained the circumstances of its ascent, and was quite conversant upon the subject. On Lt.-col. Chalmer's entering the stable, he recognised this person to be one of the Messrs. Green (the aeronauts), and who stated that the balloon was his property, and named the 'Albion.' Mr. Green was passing under the name of Brown, in order to keep all proceedings as to a balloon being in the neighbourhood a secret.

"Lord Ingestre said that further search should be made by the keepers for the shot, but that then we could do nothing more. We left Rugeley for Beau Desert, and on arriving there we all had an audience of the Marquis of Anglesey, reporting what we had seen and heard, Lord Ingestre acknowledging that he considered the experiment a failure, in which Capt. Chads and Lt.-col. Chalmer fully coincided.

"Capt. Chads and Lt.-col. Chalmer took leave of Lord Anglesey, and returned to Birmingham that night, on their way for London, considering they had now only to make the official report of the experiment.

"Lord Anglesey directed his keeper, Mr. Cockayne, to make diligent search for any of the shot that had been dropped from the balloon in its course from Haywood-park to Rugeley. Reports were received from Mr. Cockayne, dated 8th, 9th, 10th, 11th, and 12th December, 1846, and 10th January, 1847, showing the number that had been recovered, the direction in which they were found, and their penetration into the ground; he also sent up two diagrams, exhibiting (from the positions the shots were found in) the tortuous course of the balloon, which twice crossed the turnpike road from Haywood to Rugeley.

"Mr. Cockayne reports that 18 shot had been recovered: five within 100 yards of where the balloon fell; eight at about three miles from Haywood-park; and five one mile from whence the balloon started (Haywood-park). The penetration was from one to four feet, in hard gravelly soil.

(signed) "H. D. CHADS, Captain, R.N.
"J. A. CHALMER, Lieutenant-Colonel, R.A."

[We propose next month to give an analysis of Sir Howard Douglas's account of the proceedings of himself and the other commissioners appointed to consider Captain Warner's claims.]

MILITARY AND NAVAL ENGINEERING.

LIEUTENANT ROBERTS'S MORTAR.

Some experiments were recently made at Potrsmouth, to test an improved mortar, suggested by Lieut. Julius Roberts, of the Royal Marine Artillery. The mortar tried on board the Curfew, a 10-gun brig, was a 13-inch, weighing 5 tons. It was suspended between two cheeks or brackets by a wrought iron spindle or bar of 9 inches in diameter, being attached to this bar by two wrought iron shafts of 5 inches diameter to the trunnions, and a short shackle chain under the muzzle, by which the elevation is altered or maintained to 45 degrees. The brackets abovementioned stand firmly bolted to a circular oak platform 13 inches thick, having a square hole cut through it, which platform is placed to revolve over a circular hatch or hole on the deck with sufficient bearings for support, and a combing round it, in which two opposite key bolts are allowed to work to prevent the platform rising. The square hole in the platform being immediately over the circular one in the deck, the mortar, by a single 6-inch rope, passed for the purpose, when hanked over the bar and hooked to a chock and ring placed into the muzzle, is lowered, muzzle downwards, at a moment's notice, into the hold, and so secured there, by which the enormous weight of five tons is instantly removed from off the upper deck; the same rope as easily returning it to its mounted position, the muzzle chain being unshackled, or shackled when raised in position for use. By the very simple means of its suspension, the shock, on firing, by the mortar recoiling to it, is greatly reduced, and a consequent reduction of strength and weight of deck, supports, and fittings is likewise effected.

The plan of fitting her supports is admirably arranged for lightness and strength, there being eight upright "struts," or pillars, where the Scourge and other mortar vessels require from 18 to 22, besides additional beams between every one, and fore and aft beams of enormous strength (from 15 to 18 inches square) connecting the whole; saving thereby, in the fittings of Lieut. Roberts's mortar, about 20 tons of this material alone, supposing the mortar in both cases to be the same height from the keel. The jumping up of the mortar, as usually fitted, on firing, is almost as destructive to the vessel as its downward shock, and this was strikingly exemplified in the trials of the mortar fitted to the Scourge steam-sloop, where the bolt securing the mortar to the deck beams was forced upwards with its key-bolt through an iron plate into the beams, the nut requiring screwing up every time, and the muzzle requiring to be lashed down also every time to prevent the mortar jumping backwards. By the principle of Lieutenant Roberts's plans, these evils are entirely removed, the mortar lying harmlessly and only seeking to return to its inert position on the recoil. The platform traverses on an iron bull-ring, and works most easily with two single tackles. It occupies no more room on deck than the present mortar beds; by being suspended as above described, it can be fired to the greatest nicety, the direction of the object fired at being simply taken by two small iron pickets in line with the axis, instead of that awkward and very uncertain method, when a vessel is in motion, by a plumb-line. The mortar just tried is fitted on a vessel in no way calculated to stand any concussion, should any have taken place. These many and very important advantages over the old mortar vessels are bodied in so simple a construction, as to render Lieutenant Roberts's mortar available for any class of vessels.

ARMAMENT FOR WAR STEAMERS.

The Lords Commissioners of the Admiralty, after considerable experience of the power of the various steam frigates and other steamers in the Royal navy, as regards their capabilities of bearing heavy armaments, have resolved to fix the following as the armament of each particular steamer. Vessels of similar, or nearly similar, tonnage and horse-power, are to be arranged in classes:—

Steamers Propelled by Paddles.

STEAM SHIPS.—Terrible, 1,850 tons, 800-horse power; main deck: four 56-pounders of 97 cwt., 11 feet in length; four 8-inch guns of 65 cwt., 9 feet; the 56-pounders on pivot slides, and carriages; the 8-inch guns on common carriages—upper deck: four 56-pounders of 97 cwt., 11 feet, on pivot slides, and carriages; four 10-inch guns, 85 cwt., 9 feet 4 inches, on common carriages: total guns, 16. Penelope, 1,616 tons, 650-horse power; main deck: eight 8-inch guns of 65 cwt., 9 feet, on slides and carriages; two 68-pounder carronades of 36 cwt., 5 feet 4 inches, on Hardy's compressor carriages—upper deck: two 68-pounders of 95 cwt., 10 feet, on pivot slides and carriages; four 8-inch guns of 65 cwt., 9 feet, on slides and carriages: total, 16. Retribution, 1,611 tons, 800-horse power; main deck, none (but it is arranged that all steam ships which do not carry an armament on the main deck shall, if possible, carry four 32-pounders of 50 cwt., for head and stern firing)—upper deck: two 68-pounders of 95 cwt., 10 feet, on slides and carriages to pivot; four 10-inch guns, 85 cwt., 9 feet 4 inches, on slides and carriages: total, 6.

STEAM FRIGATES.—Class 1. Avenger, 1,444 tons, 650-horse power; and Birkenhead, of 1,400 tons, 500-horse power. Upper deck: two 68-pounders of 95 cwt., 10 feet, on slides and carriages to pivot; four 10-inch guns, 85 cwt., 9 feet 4 inches, on slides and carriages; total, 6. At present the Avenger carries, by way of experiment, two 32-pounders of 65 cwt., instead of two of the 10-inch guns.—Class 2 (A). Odin, 1,326 tons, 500-horse power. Main deck: 32-pounders, 56 cwt., 9 feet 6 inches, on common carriages. Upper deck: two 68-pounders, 95 cwt., 10 feet, on pivot slides and carriages; four 10-inch guns, 85 cwt., 9 feet 4 inches, on slides and carriages; total, 12. The steamers also belonging to this class are the Sidon and the Leopard.—Class 2 (B). Gladiator, 1,210 tons, 430-horse power; Sampson (450-h.p.); Centaur (540-h.p.); Dragon (560-h.p.); Firebrand (400-h.p.); Vulture (400-h.p.); and Cyclops (320-h.p.). Upper deck: two 68-pounders, 95 cwt., 10 feet, on pivot slides and carriages; four 10 inch guns, of 85 cwt., 9 feet 4 inches, on slides and carriages; total, 6.

STEAM SLOOPS.—1st class. Gorgon, 1,111 tons, 320-horse power; Bulldog (500), Fury (515), Inflexible (378), Devastation (400), Sphynx (500), Cormorant (300), Thunderbolt, since wrecked in Algoa Bay (300), Virago (300), Eclair (287), Driver (280), Geyser (280), Growler (280), Styx (280), Vixen (280), Spiteful (280), Stromboli (280), and Vesuvius (280). Upper decks: one 68-pounder of 90 or 95 cwt., 10 feet, and one 10 inch, 85 cwt., 9 feet 4 inches, on pivot slides and carriages. Four 32-pounders of 42 cwt., 8 feet, on Hardy's slides and carriages. Total for all vessels of this class, 6.—2nd class: Medea, 835 tons, 350-horse power, Salamander (220), Hydra (200), Hecate (240), Hecla (240), Hermes (220), and Trident (350). Upper deck: two 10 inch guns, 65 cwt., 9 feet 4 inches, on pivot slides and carriages. Four 32-pounders, 25 cwt., 6 feet, on Hardy's compressor carriages. Total, 6.—3rd class: Ardent, 810 tons, 200-horse power, Alecto (200), Polyphemus (200), Prometheus (200). Upper deck: one 32-pounder, 45 cwt., 8 feet 6 inches, on pivot slides and carriages. Total, 3. A special exception is made in this class of the Janus, 763 tons, 220-horse power, which carries only two 10 inch guns of 85 cwt., 9 feet 4 inches, on pivot slides and carriages.

BOMB STEAMERS.—Scourge, 1,124 tons, 420-horse power; upper deck, one 68-pounder, 95 cwt., 10 feet, on slide, and carriage to pivot; one 13-inch mortar: total, 2.

STEAM GUN-VESSELS.—Class 1. Firefly, 550 tons, 220-horse power, Blazer (126), Tartarus (136), and Flamer (120). Upper deck, one 32-pounder, 42 cwt., 8 feet, on slide and carriage to pivot. Two 32-pounder carronades, 17 cwt., on Hardy's carriages.—Class 1 (A). Grappler 559 tons, 220-horse power. Pluto (100), Columbia (100), Oberon (260), Triton (260), Antelope (260), Acheron (170), and Volcano (140). Two 32-pounders, 56 cwt., 9 feet 6 inches, on slides and carriages to pivot; two 32-pounders, 25 cwt., 6 feet, on compressor slides and carriages; total, 4. Class 2 (A). Spitfire (432) tons, 140-horse power. Porcupine (132), Lucifer (180), Avon (170), Gleaner (130), Shearwater (160), Kite (170), Lighting (100), Meteor (100), and Comet (80). One 18-pounder of 20

cwt., 7 feet, on slides and carriages to pivot; two 18-pounder carronades, 10 cwt., 7 feet, on Hardy's compressor carriages; total, 3.—Class 2 (B). Torch 345 tons, 154-horse power, Locust (100), Harpy (200), Jackal (150), Lizard (150), Bloodhound (150), and Myrmidon (150). One 18-pounder gun of 22 cwt., 7 feet, on pivot slides and carriages, and two 18-pounder carronades, 10 cwt., 7 feet, on Hardy's carriages.

STEAM PACKETS.—*Wildfire*, 186 tons; *Fearless, Dasher, Monkey, and Dwarf*. Two 6-pounder brass guns of 6 cwt.

TUGS.—*Echo*, 295 tons, 140-horse power, *African and Confidence*. Two 32-pounders of 56 cwt., 9 feet 6 inches, on pivot slides and carriages.

TROOP-SHIPS.—Rhadamanthus, 813 tons, 220-horse power, Dee (220), and Alban (120). Four 32-pounders of 42 or 56 cwt., 8 feet, on common carriages.

Steamers Propelled by Screws.

STEAM FRIGATES.—Class 1. Simoon, 1,953 tons, 780-horse power. Main deck: twelve 32-pounders, 56 cwt., 9 feet 6 inches, on slides and carriages. Upper deck: two 68-pounders, 95 cwt., 10 feet, on pivot slides, and carriages; four 10-inch guns, 85 cwt., 9 feet 4 inches, on slides and carriages. Total, 18. Vulcan, 1,747 tons, 700-horse power. Main deck: eight 32-pounders, 56 cwt., 9 feet 6 inches, on slides and carriages. Upper deck: two 68-pounders, 95 cwt., 10 feet, on pivot slides, and carriages; four 8-inch guns, 65 cwt., 9 feet, on slides and carriages. Total, 14. Termagant, 1,556 tons, 620-horse power; Dauntless, 520; Euphrates and Vigilant, 520. Main deck: eighteen 32-pounders, 56 cwt., 9 feet 6 inches, on common carriages. Upper deck: two 68-pounders, 95 cwt., 10 feet, on pivot slides, and carriages; four 10-inch guns, 85 cwt., 9 feet 4 inches, on slides and carriages. Total 24.—Class 2.—Megara, 1,391 tons, 556-horse power, and Pegasus (510). Main deck: four 32-pounders, 56 cwt., 9 feet 6 inches, on slides and carriages. Upper deck: two 68-pounders, 95 cwt., 10 feet, on pivot slides, and carriages; four 8-inch guns, 65 cwt., 9 feet, on slides and carriages. Total, 10.

STEAM SLOOPS.—Class 1.—Conflict, 992 tons, 400-horse power, Desperate, Niger, Enchantress, Falcon, Basilisk, and Florentia. Upper deck: one 68-pounder, 95 cwt., 10 feet; one 10-inch gun, 85 cwt., 9 feet 4 inches, both on pivot slides and carriages; six 8-inch guns, 65 cwt., 9 feet, on slides and carriages; total, 8.—Class 2.—Encounter, 895 tons, 360-horse power, and Harrier. Upper deck: one 68-pounder, 95 cwt., 10 feet; and one 10-inch gun, 85 cwt., 9 feet 4 inches, both on pivot, slides, and carriages; four 8-inch guns, 65 cwt., 9 feet, on slides and carriages; total, 6. Class 3.—Rattler, 888 tons, 200-horse power; and Phœnix, 260; one 8-inch gun, 65 cwt., 9 feet; one 32-pounder, 56 cwt., 9 feet 6 inches; four 32-pounders, 25 cwt., 6 feet, on pivot slides, and carriages, or otherwise if necessary; total, 6.

STEAM GUN-BOATS.—1st Class.—Rifleman, 483 tons, 202-horse power, Sharpshooter, Archer, Parthian, Sepoy, and Cossack; one 68-pounder, 95 cwt., 10 feet; and one 10-inch gun, 85 cwt., 9 feet 4 inches, on pivot slides, and carriages; two 32-pounders of 25 cwt., 6 feet, on Hardy's carriages. Total, 4.—2nd Class.—Teazer, 301 tons, 100-horse power. Minx, Boxer, and Biter; one 8-inch gun, 65 cwt., 9 feet, on pivot slides, and carriages; one brass 6-pounder. Total, 2.

STEAM GUARD-SHIPS WITH AUXILIARY POWER.—Edinburgh, 1,772 tons, 450-horse power. Ajax, Blenheim, and La Hogue. Lower deck: Twenty-six 42-pounders, 66 cwt., 9 feet 6 inches, on common carriages. Quarter deck: Two 56-pounders, 87 cwt., 10 feet, on pivot slides, and carriages; four 10-inch guns, 85 cwt., 9 feet 4 inches, on slides and carriages. Forecastle: Two 56-pounders, 87 cwt., 10 feet, on pivot slides, and carriage. Total, 56 guns.—Eurotas (fr.), 1,168 tons, 350-horse power. Horatio, Seahorse, and Forth. Main deck: Twenty 42-pounders, 66 cwt., 9 feet 6 inches, on common carriages. Quarter-deck: One 56-pounder, 87 cwt., 10 feet, on pivot slides, and carriages: two 8-inch guns, 65 cwt., 9 feet (or two 10-inch guns of 85 cwt., 9 feet 4 inches), on slides and carriages. Forecastle: One 56-pounder, 87 cwt., 10 feet, on pivot slide and carriage. Total, 24.

STEAM FRIGATES WITH AUXILIARY POWER.—Arrogant, 300-horse power. Main deck: Twenty-two 32-pounders, 56 cwt., 9 ft. 6 in.; and six 8-inch guns, 65 cwt., 9 ft, on common carriages. Quarter-deck: one 68-pounder, 90 or 95 cwt., 10 feet, on pivot slide and carriage; sixteen 32-pounders, 32 cwt., 6 feet 6 inches, on Hardy's carriages. Forecastle: One 68-pounder, 90 or 95 cwt., 10 feet, on pivot slide and carriage. Total, 46.—Amphion, 300 horse power. Main deck: Fourteen 32-pounders, 56 cwt., 9 feet 6 inches, and six 8-inch guns, 65 cwt., 9 feet, on common carriages. Quarter-deck: One 68-pounder, 90 or 95 cwt., 10 feet, on pivot slide and carriage; eight 32-pounders, 25 cwt., 6 feet, on compression carriages. Forecastle: One 68-pounder, 90 cwt., 10 feet, on pivot slide and carriage. Total, 30.

This return does not include the numerous packets that ply as mail steamers on the various stations round the coast and in our colonial possessions.

Niagara Wire Bridge.—It is stated in the *Rochester Democrat*, that the Niagara Suspension Bridge Company will shortly proceed to the erection of a wire bridge across the Niagara river—the Queen's assent having been obtained. The whole of the stock, 200,000 dollars, has been taken—one half in Canada, and the remainder in New York.

NOTES ON FOREIGN WORKS.

Munich Art-Union.—Audiatur et altera pars.—The Munich Union is on the decrease, evidenced by the reports both of 1845 and 1846. Surely an association which possesses an annual income of nearly 40,000 florins (a large sum of money at Munich!),—might, all other advantages combined, have done more. The public taste, to mention one incident, does not seem to go apace with higher art-tendencies, for amongst 127 pictures open to prizeholders, only *three* historical ones were chosen;—here also the mere hunting after portraits and *genre* painting. Compared with this decline of the Munich art-union, even that of the Düsseldorf art-friends does not bear a comparison—which latter have had painted an altar-piece for the Cathedral of Cologne, adorned the guildhall of Elberfeld with frescoes, and provided similar embellishments for the Emperors'-hall of Aix-la-Chapelle. Even the Art-Union publication (*Vereinsblatt*), which might easily have been elevated to an organ of real art-value, very seldom rises beyond the sphere of ephemeral art, and labours under a mere hunting after external appearances and picturesque effects. This year's exhibition, also, does not afford any very cheerful prospects, although the king has sent to the exhibition some Dutch paintings of his own private gallery. In the department of sculpture, L. Schaller has exhibited a St. Bernard in bronze; and the model of a Penelope, by Brugger, may be also mentioned.

The Valley of Chamonix has been the scene of an awful event. By an avalanche which fell from the Aiguilles-Rouges, and filled the bed of the Arve, the small village of Des Prats on the banks of the rivulet, was completely buried in *débris* of rock and snow, with some considerable loss of life. Another avalanche which came down lately from the crags of the Eisenstein, in Tyrol, buried several persons who were on the return home.

Road over the Alps.—The Sardinian government has given orders to repair and open the gigantic road, which leads from the south of France (Briançon) to Italy. This road over the Mont Genèvre was constructed by Napoleon, in a most solid and costly manner, but has since been neglected and got out of repair and use. It will be of great importance when Turin and Pignerol are connected by a railway.

Public Works in Senegal.—Captain Grammont, R.N. of France, the governor of the above settlement, in opening the legislative assembly, adverted, at some length, to the public works to be executed in the colony. Amongst these, a regulation of the harbour of St. Louis, embankments of the river, and draining of its banks are conspicuous. His excellency very properly observed, that by such improvements the native (Negro) workman will be formed, and the process of material civilisation of Africa advanced.

Legislation of Rivers and Watercourses.—The French Congres Agricole, presided by Prince De Cazes, have discussed the above subject at great length, when Messrs. Toucqueville, Beaumont, and others, were heard. The first fact resulting from these debates is, that there is in France an act of the Legislature relating to these subjects—viz., that of 14th Floréal on XI. Some, however, thought that this law is rather for preventing the bank-people (riverains) availing themselves of the hydraulic advantages of their position in the improvement of their lands. The congress, in fine, emitted several opinions, which will have some weight on the legislature and the government. Amongst these, was the suggestion that the government would watch the execution of the laws relating to the *curage* (flowing) of water not available to navigation—lakes, ponds, and brooks; that the former usages, local regulations, &c. of each county, relative to this subject, be collected, and laid before a board of magistrates and proprietors, for bringing them in concert with the general legislation of the land. The congress recommended to government the appointment of regular officers of the *cours d'eau*. It was also suggested, that the forced participation of proprietors interested in the execution of public works—hitherto merely restricted (by the law of Sept. 16, 1807) to the dykeing of the sea shore and the banks of rivers—should be extended to all works relating to the management and distribution of water. The congress likewise requested, that government should direct its attention to the amelioration of bogs and marshes, by the cutting of great draining canals (*fossées d'assainissement*), to allow the escape of the waters and moisture of whole districts—on which account, no legislative enactment has been hitherto made. (*C'est tout comme chez nous.*)

Navigation of the Seine.—Important works have been begun at Paris for improving the navigation of the river. At la Rapée the basin (*port*) is dredged of stone. Nearly at the embouchure of the canal of St. Martin, a jetty is building for the discharge of goods, for which the Boulevard Contrescarpe will be sacrificed, and all its houses demolished. The whole quay on the left bank, from the Pont de l'Archevêché to the Petit Pont, is taken off, and is to be rebuilt with an inclined road.

Strange Inauguration of a Public Building at Constantinople.—The foundation stone of the branch building of the College of Medicine, which is to be erected near the cemetery of Pera, has been laid with much ceremony. The work has been for some time delayed, because the chief astrologer (Mynedjim-Bachi) of the sultan had declared, that no other day than the 20th February would be propitious for that purpose. Still, the atmosphere did not concur with the right reverend gentleman, as the cemetery presented a lake of mud, caused by the incessant rain and snow which fell during the day.

Canina of Rome.—M. Canina is one of the most active and, we may say, most sterling literary characters of modern Rome. Scarcely has he brought out his great work on general architecture, than "Le Basiliche Christiane di Roma" (a work of older date) appears in a second edition. It is hardly credible how such a performance—145 copper-plate engravings and 192 pages of text, in folio—could be completed in so short a period. At the same time, Cavaliere Canina has published a second edition of "Foro Romano," and has nearly completed a description of all the Etruscan antquities, which either have been discovered on Roman ground or are preserved in its museums. And, therefore, while others are fumbling and *shuldering* how and what to produce, this man grasps at once at everything worthy about him—verifying the old axiom, *audere sapere*. The "Basiliche," moreover, are a work of great practical usage, containing a mass of artistic and professional information and hints, which it would, no doubt, have taken most other men years to find out and collect. The text dwells mostly on the statement and elucidation of facts, which none but a practical architect of M. Canina's stamp could give due justice to—he, who has passed all his life amongst the grandeous remains of Rome, and has searched for and studied those traditions and rules of construction, which have been current there for many centuries past. We trust these few hints will suffice to fix attention to the deep study and research of this last production of the Roman *architetto*.

Polytechnics in Austria.—The emperor of Austria has ordered the establishment of polytechnic institutions, at the charge of the state, at Linz, Brünn, Laybach, and Inspruck. They will comprise the usual course of a three years' (mostly gratuitous) tuition, and be provided with chemical laboratories, polytechnic and industrial collections, libraries, &c. By this addition, each of the chief county towns will have its central polytechnic institution; while agricultural schools, which are now to be established throughout the kingdom, will serve as the necessary complement of national education.

Berlin Society for the Improvement of the Working Classes.—When the great Industrial Exhibition of 1844 had led the minds of Prussian philanthropists and statesmen towards this subject, the experience in the mechanism of such huge associations was so little developed, that a great many obstacles presented themselves, which are now, happily, overcome. Last month, a general meeting took place, when the statutes of the Society were confirmed by the home secretary of state. The main difficulty hinged in the wish of the committee to establish branch Societies throughout the country, which would have made them a kind of *corresponding* society. This has been so changed, that these branches will be unconnected with the central body at Berlin.

Hall of Liberty, in Bavaria.—This structure, whose name (*Befreyungs Halle*) we seem to have truly rendered and translated, is now occupying the chisel of Schwanthaler. Four of the splendid cycle of Victory statues, before noticed (*ante* p. 34), which have to adorn the Hall, are already modelled, and will be reproduced in marble by other artists, as their number will amount in all to thirty-two. It has likewise been previously mentioned that they will stand on a continuous circular stylobate, every two holding a shield, &c. It has become known, of late, that the original idea of forming a wreath as it were of statues, placed within the expanse of an immense rotunda, belongs to King Ludwig himself. The relievos of the metopes, for the Hall, in marble, are also nearly completed, as are likewise the four statues for the gable of the building, which will represent the four tribes of the Bavarian nation. Another work of M. Schwanthaler is now completed—namely, the shield of Heracles; it is cast in bronze and gilt. The original is destined for the Emperor of Austria, and four copies for other sovereigns.

A new Theatre at Vienna.—The foundation of a grand new theatre near the Körnthmer-Thor, at Vienna, has been laid. The theatre is to bear the name of the National Theatre, and is to be fitted up on a scale of great magnificence. It is to be finished in two years.

Railway in Switzerland.—The project for a railway running from the Mediterranean, through Switzerland, to the North of Germany includes two gigantic works of art, that by most of those who have been consulted are deemed impossible of execution. These are the piercing of Mount Lukmanier (the *Locus Magnus* of the ancients), to gain access from the Valley of the Tessin to the Valley of the Rhine—and that of the Alps for the line which will link Sardinia with France in the portion comprehended between Oulx and Modane. The engineer Ricci, however, to whom the Sardinian government has intrusted the work, and whom the Swiss and Bavarian government have adopted for their respective shares in the undertaking, after a careful study of the ground is of opinion that the boring of these granite masses is practicable; and has invented a mechanical apparatus for the excavation of the huge tunnels, which has been approved by the Committee of Public Works, and is to be put into immediate operation.

India.—The Ganges Canal, on which £20,000 annually has hitherto been grudgingly bestowed, is now to be proceeded with at the rate of £250,000 a year; it will be completed by 1851. It will irrigate 8,000,000 of acres now comparatively barren, and save 2,000,000 of people from the periodical visitations of famine. Another canal, leading from the Sutlej, 90 miles into the Bhuttee country, is being surveyed.

NOTES OF THE MONTH.

The New House of Lords—Mr. Barry has given us what may be called the first instalment of the new Palace at Westminster, in the opening of the House of Lords. Of this building we have engravings in preparation, which we expect shortly to lay before our readers, when we shall proceed to give a description of this great work. In the meantime, we may say that it has been received with much applause, and is considered as justifying the time, labour, and money expended upon it. It is one of the most superb halls in the world, becoming its purpose of the throne and seat of empire of the most powerful and most wealthy nation in ancient or modern times.

Army and Navy Club.—There were 69 designs sent in for competition for the New Club Room. We understand that during the last month the members of the club were regularly besieged with canvassers for favour; such a practice is highly disgraceful to a profession like that of architecture, and ought to be denounced at the Institute as most dishonourable—but will the Institute stir in the affair? Mr. Tattersal is the successful competitor for the first premium, and Messrs. Fowler and Fisk for the second premium. The designs will be exhibited to the public by tickets, to be obtained of the secretary, until Thursday, 6th inst.

The great engineering achievement of the last month is the opening of the Birkenhead docks, which was celebrated by a sumptuous ceremonial.

It seems now to be decided that the railway from Calcutta to the Upper Provinces of India is to be guaranteed by the Government.

The Great Western steamer has been sold to the Royal Mail Steam Packet Company for 25,000*l.*, exclusive of her plate.

In the course of the last month, the new entrance of the British Museum was thrown open to the public. It is on a large scale.

It is understood that Barry has executed for the Baron de Goldsmid a grand ball-room, which no stranger has yet seen, and the opening of which will be one of the attractions of the season. It is said to be one of the best pieces of decoration in this way yet executed, and to be in the most magnificent style—worthy of the great capitalist and the great architect.

Royal Botanic Gardens.—The winter garden of the Royal Botanic Society in the Regent's Park, which is nearly an acre of garden under glass, has, during the spring, assumed a picturesque appearance, and has been so successful, that with the reduction of the price of glass, this kind of construction is likely to exten. At the present moment, however, we have only the Regent's Park specimen by Decimus Burton, and Marnock, to set against the large winter gardens at St. Petersburgh and Berlin.

Kew Gardens.—The great palm-house at Kew, by Decimus Burton, is getting on. The ground part constitutes a hot air vault or chamber, over which is laid an acre of grating, on which the tubs and pots containing the plants are placed. The design is grand and novel.

A vote has been carried through the House of Commons for the completion of the base of the Nelson column.

The foundations of Miss Burdett Coutts's church in Westminster have been laid.

Among the novel suggestions for the improvement of architecture lately promulgated, is one from New Jerusalem by Mr. D'Israeli, who says in his "Tancred"—"What is wanted in architecture, as in so many things, is—a man. Shall we find a refuge in a committee of taste? Escape from the mediocrity of one to the mediocrity of many? We only multiply our feebleness, and aggravate our deficiencies. But one suggestion might be made. No profession in England has done its duty until it has furnished its victim. The pure administration of justice dates from the deposition of Macclesfield. Even our boasted navy never achieved a great victory until we shot an admiral. Suppose an architect were hanged? Terror has its inspiration as well as competition."—The suggestion is novel, but we must leave the profession to decide on its practicability. Perhaps, next time, Coningsby will suggest who is to be the first victim.

Obituary.—It is with deep regret that we have to record the death of Mr. Charles Holtzapffel, of Charing-cross, aged 41, which took place on the 11th ult. His works on "Turning and Manipulation," we spoke of at the time they were published, as most valuable books, and we repeat they are such that no engineer's library ought to be without. Mr. Holtzapffel was a member of the Council of the Institution of Civil Engineers, and chairman of the Committee of Mechanics at the Society of Arts, and stood pre-eminent as a mechanician of inventive ingenuity.

Copper Ore.—M. Dufrénoy presented to the Academy of Sciences, in the name of Messrs. Rivot and Phillips, engineers, a paper relative to a new mode of operating on copper ore. It consists of a precipitation of the copper by iron, and applies principally to the sulphuretted ores.

Water Test.—M. Dupasquier communicated to the Academy of Sciences, a new mode of testing water, in order to ascertain the quantity of organic matter held in solution. He puts into a glass globe from one to two ounces of water, to which he adds a few drops of a solution of chloruret of gold, sufficient to give it a slight yellow tinge. He then boils the water. If it contains only the ordinary quantity of organic matter of potable water, the yellow tinge remains as it was, even if the ebullition be prolonged. If, on the contrary, the quantity of organic matter be in excess, the water becomes first brown, and then assumes a violet tint, which announces the decomposition of a salt of gold by the organic matter. By

prolonging the ebullition, the violet tint becomes deeper and deeper if the quantity of organic matter be considerable. But the mere brown tint alone serves to show that the quantity of organic matter exceeds the ordinary proportion.

Flax Adulteration.—At the Academy of Sciences, Paris, M. Boussingault read a report of a committee on a paper by M. Vincent, relative to the means employed in detecting by a chemical test the admixture of *phormium tenax*, or New Zealand flax, with the hemp and flax of European growth and preparation. The *phormium tenax* does not possess certain qualities essential for naval cordage, and it was considered important to discover the means of detecting its presence. M. Vincent has found that if the *phormium tenax* be immersed in pure nitric acid, its fibres, owing to the presence of some azotic substance, take a blood-red tint; which is not the case with the hemp and flax admitted for use in the navy. Thus it is very easy, by subjecting a rope to the action of nitric acid, to discover whether there has been any admixture of *phormium tenax*. The report of the committee confirms the statement of M. Vincent.

Manures.—At the Academy of Sciences, Paris, a paper was received from M. J. Persoz relative to the influence of certain manures on vegetation. He states that a mixture composed of potass, dried blood, and goose dung was found to have great effect upon vines. He also mentions a manure for hortensias, composed of potass and burnt bones treated with nitric acid.

Railway Abattoir.—At the Trowse station, Norfolk, an abattoir, consisting of two sets of slaughter-houses, has been built and fitted up with every convenience for slaughtering 100 beasts and 300 sheep daily. The buildings and yard are enclosed within high brick walls, and the yard has been divided into compartments or pens for the beasts and sheep. Adjoining the slaughter-house, there is a large tank to supply water. Close to the open end of the houses there is a siding to and from the railway, on which the trucks run to be loaded with carcases.

Iron Bridge Rails.—Mr. Wood, of the British Iron Company's Works, Abersychan, has succeeded in rolling bridge-rails weighing 90 lb. per yard, 30 feet long.

The Admiralty Electric Telegraph.—The lords of the Admiralty have at length directed the extension of the South Western Railway subterranean electric telegraph to the Admiralty at Whitehall. It will branch off in the Strand near the company's present offices.

The "Prince Metternich" Steam Vessel.—This splendid steamer, of 600 tons, and 200-horse power, fitted with Morgan's patent wheels, made her trial trip on Thursday, April 1st, for the purpose of ascertaining her draught of water and average speed, at the standard mile in Long Reach. This vessel and her machinery are the joint production of Messrs. Ditchburn and Mare, of Blackwall, and Messrs. Penn, of Greenwich; she was built for the Danube Steam Navigation Company, and constructed expressly to navigate between Galatz and Constantinople, and it is intended she should combine the properties of a sea-going and river steamer, as far as these qualities can be united. The contractors were bound by special agreement to produce a vessel that should realise an average speed of 15 miles per hour, and not to draw more than six feet water with 120 tons of dead weight on board—which she more than realised. At the trial trip she passed up and down the mile six times, with and against the tide, at an average speed of 15¾ miles per hour.

Important Saving in Draining.—A correspondent of the *Nottingham Mercury* states that an enormous saving is to be effected by the use of pipe-tiles made by machinery, instead of horse-shoe tiles made by hand. "There are at this time," he says, on the authority of the chairman of Excise, "in the county of Nottingham, 97 brick and tile-yards, making in the year, by hand, not less than 8,000,000 drainage tiles." The cost of 8,000,000 horse shoe and 4,000,000 flat tiles is about £16,000, while 8,000,000 pipe-tiles—with which flat ones are not required—may be made for £6,034, or at a saving of £10,866. The writer adds that last summer he made 500,000 pipe-tiles at from 10*s.* to 12*s.* per thousand, by a machine which cost him no more than £35. The superiority of pipe-tiles is very great. "They are stronger and less liable to break, both in carriage and in use. They require no flats; they lie more evenly and securely in their bed. No vermin can get into them. They form a better channel for the water, and scour themselves clear of silt. They are much lighter and more portable."

Durham Cathedral.—The inappropriate wooden screen which separated the nave from the choir, and which was placed there by Prior Wessington, between the years 1416 and 1445, together with the great organ immediately above it, has been removed. The organ is to be placed on the north side of the choir, immediately opposite to the bishop's throne, where it will remain permanently if the situation on trial proves suitable. The end stalls will then be thrown back, so as to make more room in the choir—a change long wanted—and a temporary iron railing will be run across to separate the choir from the nave, which railing will be replaced by a permanent screen, when it shall have been determined what description would be most appropriate. A low stone Gothic screen is contemplated. The visitor, on entering the cathedral, will now be struck with the uninterrupted and magnificent view which he obtains of the interior from west to east.

LIST OF NEW PATENTS.

GRANTED IN ENGLAND FROM MARCH 27, TO APRIL 22, 1847.

Six Months allowed for Enrolment, unless otherwise expressed.

Charles May, civil engineer, of Ipswich, Suffolk, for "Improvements in railway chairs, the fastenings to be used therewith, and in trenails."—Sealed March 27.

John Henry Griesbach, of Carlton Villas, Maida Vale, for "Improvements in the construction of railways, and in engines and carriages to run thereon."—March 29.

Alexander Morton, of Morton-place, Kilmarnock, for "Improvements in printing warps."—March 29.

John Fisher, the younger, mechanician, of Radford Works, Nottingham, for "Improvements in the manufacture of lace or weavings."—March 29.

Samuel Hardacre, machinist, of Manchester, for "certain Improvements in machinery or apparatus for opening and for carding cotton and other fibrous substances, and for grinding the cards of carding engines." (Partly a communication.)—March 29.

Henry Woodfall, paper maker, of Footscray, Kent, for "certain Improvements in paper-making machinery."—March 22.

Samuel Millbourne, paper-maker, of Saint Mary's, Cray, Kent, for "Improvements in the manufacture of paper."—March 29.

[The above two patents being opposed at the Great Seal, were not sealed till the 29th March, but are dated the 3rd October, 1846, the day they would have been sealed had no opposition been entered by order of the Lord Chancellor.]

Robert Jones, hot presser and finisher, of Wardour-street, Soho, for "certain Improvements in dressing or finishing goods or fabrics."—March 29.

George Robert Skene, Esq., of Bedford, for "Improvements in making and refining infusing and decoctions."—March 30.

William Phillips Parker, gentleman, of 48, Lime-street, in the City of London, for "an Improved mode of manufacturing cigars." (A communication.)—April 1.

Benjamin Tucker Stratton, agricultural machinist, for "Improvements in railways, and in wheels and other parts of carriages for railways and common roads; partly applicable in the construction of ships or other vessels, and improvements in the machinery for manufacturing certain parts of the same."—April 6.

Charles de Bergue, of Arthur-street, west, in the City of London, engineer, and John Coope Hadden, of No. 11, Upper Woburn Place, in the county of Middlesex, civil engineer, for "Improvements in wheeled carriages, and in panels and springs for carriages and other purposes."—April 8.

William Thargе Stevenson, of Upper Baker street, Lloyd-square, Middlesex, gentleman, for "Improvements in regulating the generating of steam in steam-boilers."—April 8.

David Napier, of Glenhellish, Strachen, Argyleshire, for "Improvements in steam engines and steam-vessels."—April 8.

Stephen Moulton, of Norfolk street, Strand, Middlesex, gentleman, for "Improvements in the construction of bridges." (A communication.)—April 8.

Patrick Moir Crane, of Ynisceedwyn iron-works, near Swansea, for "Improvements in the manufacture of iron."—April 8.

John Mollett, of Austin Friars Passage, for "Improvements in fire-arms and in cartridges." (A communication.)—April 15.

Peter Claussen, of Leicester-square, Middlesex, gentleman, for "certain Improvements in weaving machinery, and in the preparation of the materials employed in weaving." (A communication.)—April 15.

Charles Minors Collett, of Chancery-lane, gentleman, for "certain apparatus and arrangements for affording additional security in locks." (A communication.)—April 15.

James Bobson, of Dover, engineer, for "a new and improved instrument to be used in crushing or expressing oil from vegetable and other substances, and in making oil cake, and which instrument is applicable to the moulding, pressing, and manufacturing the same and other articles from plastic materials."—April 15.

Stephen White, of Winchester-row, New-road, clerk, for "a new means of producing gas, both as to apparatus and materials, from which the gas is produced."—April 15.

Alfred Vincent Newton, of Chancery-lane, mechanical draughtsman, for "Improved apparatus to be applied to steam boilers." (A communication.)—April 16.

Samuel Childs, of Earl's-court-road, wax chandler, for "certain Improvements in the manufacture of candles, and in preparing and combining certain animal, vegetable, and mineral substances, applicable to the manufacture of candles and other uses."—April 15.

George Holworthy Palmer, of Surrey-square, Old Kent-road, civil engineer, for "an Improved method or mode of producing inflammable gases of greater purity and higher illuminating power than those in use, and also in the arrangement of the apparatus employed for the purpose, and which apparatus may be applied to other similar purposes."—April 17.

Joseph Woods, of Bucklersbury, engineer, for "certain Improvements in springs for supporting heavy bodies and resisting sudden and continuous pressure." (A communication.)—April 20.

Osmon Giddy, of Hereford Lodge, Old Brompton, gentleman, for "Improvements in apparatus for sweeping and cleansing chimneys and flues."—April 20.

Philip Burnard Ayres, of Holland-street, Fitzroy-square, doctor of medicine, for "certain plans and improvements in preparing putrescent organic matters, such as night-soil, the matter in suspension in the water of sewers, and other similar matters, for the purpose of manure or for other purposes, and for apparatus for the same."—April 20; four months.

John Walker, of Crooked-lane, engineer, for "Improvements in certain hydraulic and pneumatic machines, and in the applications of steam or other power thereto."—April 22.

John Fisher, the younger, of Radford Works, Nottingham, mechanician, for "Improvements in arranging or folding certain narrow fabrics."—April 20.

Samuel Kenrick, of Handsworth, Stafford, iron founder, for "certain Improvements in preparing or forming moulds for casting metals."—April 20.

George William Rowley, of Welbeck-street, Cavendish-square, gentleman, for "Improvements in the construction of carriages, and in apparatus to be used with omnibuses and other carriages."—April 20.

Thomas Brown, of Muscovy-court, Tower-hill, for "Improvements in machinery for raising and lowering weights." (A communication.)—April 20.

ERRATA.—In the article "Combination of Telescope," &c., in our last number, page 102, line 29, *for* "instead of telescopes—microscopes will come into use," *read*—"instead of microscopes—telescopes."

GLANCE AT SOME OF THE ATTRIBUTES OF ARCHITECTURE.

By FREDERICK LUSH.

O noble Art! to honour whom unite,
Beauty, with Grandeur and Simplicity,
And bright-cheek'd Colour, lovely child of Light,
Link'd by the fairy hand of Symmetry.
O noble Art! how much we owe to thee,
Of calm and holy thought, of feelings high,
When in some splendid pile thy power we see;
Whether the broad-brow'd tower that dares the sky,
The hall by Commerce, or by Science trod,
The palace home of kings, or solemn house of God.

ANNE A. FREMONT.

Sensible of the influence of the beautiful, all highly civilised nations have surrounded themselves with it as much as possible. The Greeks continually placed before their eyes the statues of their most famous sculptors and the creations of their most famous painters; art and nature reciprocally acted upon each other;—the lover of art, quick in his perception of beauty, grew inwardly like what he beheld; whilst the natural symmetry of the sons of Greece, the grace of the female form, and the proportions of their athletæ, filled the soul of the artist with those vivid conceptions which we see embodied to a great degree in the Apollo, the Venus de Medicis, the Gladiator, and other well known statues of antiquity; and in the highest degree in the works of Phidias. So Michael Angelo imbued his mind with grandeur by the incessant contemplation of the renowned Torso;—so the pictures of the Venetian masters seem as though steeped in their city's rosy twilights and splendid sunsets. Still, beauty will not incorporate itself with the feelings of man, nor shape his works, if he be insensible to its charms. A country has boasted the finest productions of art, whilst her people remained unexcited by an admiration for them. At a period when Italy, for instance, was in possession of her exquisite monuments of taste, and abounded in all the luxuries of its climate, her people sank deeper and deeper into barbarism.

The loss of the advantages derivable from magnificent scenes, owing to a perverted temper of mind through which they are regarded, is eloquently described by Sterne:—"The learned Smelfungus travelled from Boulogne to Paris; from Paris to Rome, and so on; but he set out with the jaundice, and everything he saw was discoloured and distorted: when he returned, he wrote an account of his travels; but 'twas nothing but the account of his miserable feelings." It is not unusual to meet with those who presume to be critics, but show themselves to be only cynics. These are men with hearts too much hardened, and with eyes too much blinded, to enable them to recognise the intrinsic greatness of an object. But the beautiful cannot be justly appreciated, if the mind be not in harmony with it. We can only form a judgment of a work whilst we are in similar disposition with its author; and in possession of the same, or a superior, taste and intelligence to that which it displays. Criticism, as it relates to the fine arts, requires the exercise of the finest, the kindest, the most generous, and the most exalted sentiments and attributes of our nature. It depends upon a knowledge of our internal nature,—upon a habit of turning the mind inwardly upon its own operations, with a frequent observance of external objects. The ancient metaphysicians threw great light on the theory and practice of art,—grounding it on the philosophy of the human mind, as the moderns—especially the Germans—have done;—and a theory that would repose in security, must rest upon such a basis. Our notions of what is good in art are to be built upon certain great truths, and upon unchangeable principles: for the proof of the goodness of all principles consists in their durability; and such laws and elements of beauty can we only consider fixed and settled as are deducible from, and conformable to, the nature of the human mind.

Truth—Utility—Adaptation.—Truth is defined the standard of right reason, the perfection and the end of mind. It is as important in art as it is in morals. We prefer real to fictitious materials, the evidence of a pure taste to what is only the semblance and affectation of it, because "true and just things are in their nature better than false and unjust."* Rochefoucault says,—"*La verité est le fondement et la raison de la perfection et de la beauté; une chose, de quelque nature qu'elle soit, ne sçauroit être belle et parfaite, si elle n'est veritablement tout ce qu'elle doit être et si elle n'a tout ce qu'elle doit avoir.*" [Maxim 294.] Truth and beauty do not differ but concur in one; the real and the ideal, of which they are types, supply the one the means and materials to a work of art, the other the spirit which informs it; the former selects what is most suitable and appropriate to its purposes; the latter gives to the production the utmost perfection of which it is capable.

It was always considered that whatever is useful in architecture, should be rendered pleasing, and what is beautiful should be necessary. The *uses* of a building must be studied before its ornaments; and ornaments, however small or subordinate, must contribute to the general effect, and arise out of, or be grafted upon, the construction itself. Beauty of architecture is greatly dependent upon construction. The figures that give such sublimity to our churches and all our vast edifices, are vaults and domes; and these, at the same time, confer upon them their most essential and most noble attributes. A building may admirably fulfil its intentions in respect of utility, but it would be cold without the additional charms of painting and sculpture;—yet these arts, and all decoration, should never screen any imperfections, but should heighten the general character and mark its destination. It requires for its perfection the introduction and union of all the arts; and such a skilful management of these, that the effect of one shall not impair the effect of another,—but each aid the other and add to the great impression of the whole. In a perfect cathedral, we see the most successful achievements of the grand requirements of architecture—the profound significance and meaning of everything—the highest utility and beauty combined;—materials invested with all the magic hues of poetry, and in their forms and colours so beautifully symbolling forth the religion, as to be called by Coleridge "petrifactions of Christianity."

The architect first adapts the plan and design to its site, and to other circumstances; because the want of good arrangement, of convenience, accommodation, or of stability, and other important requisites, can never be compensated by any pictorial effect. *Vanum est quod non ad finem valet.* Besides, these defects and deficiencies always betray the absence of the necessary qualifications on the part of the designer. Without the fulfilment of the first requisites of art—without that knowledge of statics which is essential to the security and duration of a structure, the character of durability can never be impressed upon it. What makes the churches of Sir C. Wren so beautiful but their poetry?—he proved himself nevertheless to be a great master-builder. Whatever may be the style of architecture, or however various the treatment and execution of its materials; whatever perfection of forms it may exhibit; whether it present itself in the manly simplicity of the Grecian, or the rich profusion of the Gothic; its claims upon our admiration will be in proportion to its durability;—eternity being its sovereign attribute. What would be the long colonnades of antiquity, and the groining and aisles of a York Minster, if the great stones were not indissoluble and the arches in perfect equilibrium? This is their principal source of sublimity. But every work of man that is feeble and perishable suggests feelings similar to those we experience in looking on a human body that is consuming away, and in that process indicating a dissolution of that symmetry and harmony in its fabric which is the cause of its health and strength.

Symmetry—Proportion.—Symmetry produces at regular or proportioned distances of an edifice a unity of features, maintaining order and congruity, amidst, it may be, the greatest variety. The rules of

* Aristotle.

proportion, as applied to the entire design as well as in the minutest ornaments, are observable both in ancient architecture and in the Pointed style of the middle ages. Alberti, Cicognara in his work "Sull Bello," and others, give examples of arithmetic and geometric proportions for halls, apartments, &c. Different proportions belong to different edifices; and one of small dimensions, if its parts are symmetrically disposed, will affect the mind with a greatness of manner which impresses us with an idea of something superior to works bulky in themselves, though ill-contrived. The art of adjusting quantity to various circumstances is noticed by Hope in his "Historical Essay,"—"The Greeks reserved to themselves the right of giving to each, forms more restricted or multiplied, more simple or rich, and proportions more sturdy and delicate, according to the peculiar exigencies of the edifice or situation. To so great a degree was this their practice, that in these respects, between each order and the two others, an almost insensible transition exists, and that every individual instead of uniformly maintaining a vast interval between itself and the two others, such as all extreme specimens of every style present, borders closely upon the next in succession, and almost appears amalgamated with it."

In great works some disproportions far removed from the eye are not discernible; because *la grand' aria mangia*. Without this exaggeration, small parts are swallowed up by the ærial perspective, and no grand effect is produced. Hogarth in his "Analysis of Beauty," refers to the marked variety and relief given by Sir C. Wren to his spires, especially that of St. Mary-le-bow, as proofs of his superior skill on these points. The ancients, and also the mediæval builders, enhanced the importance of their works, and made them at once striking and eloquent, by the care they bestowed on certain features; the power of which spoke immediately to the soul, and excited not merely admiration, but wonder. Yet these things were dictated by optical considerations. "Objects do not appear as they are in reality, therefore the architects endeavour to make their works appear not in their true proportion, but in what they should appear."—(Ancient Maxim.) In our observations of ancient constructions, we must have remarked the various artifices had recourse to for increasing the effect of the ornaments; of boring deep holes by a drill in some parts in order to give them a more decided character when seen from the point at which they would be mostly viewed; of making certain masses stand prominently in advance of the groundwork, and the habit of working the ornaments on their plain blocks in the places they occupy in the building.

Novelty—Variety.—We estimate an architect according to the taste he evinces in forming new and pleasing combinations,—combinations in which we see the feelings which characterise the poet—which bespeak an imagination analogous to that of the poet: the goodness of the originality is the criterion of their talent. *Mens hominis avida novitatis est;* and a necessity forces itself upon the artist to supply this want,—a power of invention which does not imply a neglect of what our predecessors have done, but on the contrary, a profound study and love of their best works; as there was scarcely, for instance, any one so versed in, and so thoroughly pervaded by, the spirit and principles which animated the ancients, as M. Angelo; yet no one so independent of them—always their equal, often their superior. It is in the command of beautiful forms—in breathing new life and vigour into the marble, that man shows his sovereignty as a poet. The attempt at novelty will often yield more delight than an affectation of taste which is foreign to us; for it is an evidence of the exercise of thought, a desire to create, and a disdain of mere imitation. The mind sometimes embodies ideas which are nothing less than mental phenomena, or the effects of a peculiar organisation; which the reason finds it difficult to account for, and the judgment to approve; yet they are valuable on account of their power of awakening curiosity and stimulating reflection. Stewart in his "Philosophy of the Human Mind," speaking of the power of Imagination as connected with Fine Art, says:—"Without taste, imagination can produce only a random analysis and combination of our conceptions; and without imagination, taste would be destitute of the faculty of invention. These two ingredients of genius may be mixed together in all possible proportions, and where either is possessed in a degree remarkably exceeding what falls to the ordinary share of mankind, it may compensate in some measure for a deficiency in the other. An uncommonly correct taste with little imagination, if it does not produce works which create admiration, produces at least nothing which can offend. An uncommon fertility of imagination even when it offends, excites our wonder by its creative powers and shows what it could have performed, had its exertions been guided by a more perfect model."—Art that is the result of this uncontrolled imagination, must be tested not so much by rules and precedents to which it does not profess strictly, if at all, to adhere, as to the feelings or impressions which its effects make on our minds. Our attention must not be drawn to little errors, but to the prevailing beauties which atone for them. Small blemishes are excusable in a grand building—though of course the fewer the better; yet a building, faulty in parts, the great effect of which is imposing, is greater in art than one whose only praise is, you do not see any faults, neither do its beauties impress you. We must adjudge an architect's place in the rank of artist, by virtue of the quantity of sound intellect and true taste which he displays. On this subject Sir C. Wren says:* "An architect ought to be jealous of novelties, in which fancy blinds the judgment; and to think his judges, as well as those that are to live five centuries after him, as those of his own time. That which is commendable now for novelty, will not be a new invention to posterity, when his works are often imitated, and when it is unknown which was the original: but the glory of that which is good of itself is eternal."—Hence the necessity of referring to and studying those principles of grace, harmony, and proportion which exist in the human mind, and making them the foundation on which we proceed in all matters of design.

* "Parentalia."

HISTORY OF ARCHITECTURE IN GREAT BRITAIN.

A Brief Sketch or Epitome of the Rise and Progress of Architecture in Great Britain. By JAMES ELMES.

"Epitomes are helpful to the memory, and of good private use."
SIR HENRY WOTTON.

Although the ancient Britons may have dug caves in their hill sides and built huts in their woods for dwellings, like most aboriginal people, and formed temples from the interlaced boughs of trees in their groves—all of which are types and prefigurations of styles in architecture; yet its first approach to the dignity of a Fine Art in Britain must be attributed to its Roman discoverers. This great and powerful people carried their arts into every country they subjugated, and civilisation followed their eagles among the remotest barbarians of the North. When Cæsar landed in Britain, he found its inhabitants in as rude a state of barbarism as we did the New Zealanders or the inhabitants of Tahiti, on our first visit to those places. The newly discovered country benefitted greatly by the arts, learning, and civilisation of their invaders, who, wisely appreciating the natural wealth and resources of the country, planted it as a Roman colony,—to the reciprocal benefit of both people.

From the period of the establishment of the Romans in Britain to about the middle of the fourth century, the arts of civilised life made rapid progress; domestic architecture brought comfort and taste into their dwellings; and the sister arts of painting and sculpture added taste and elegance to the most wealthy. A Roman army always brought in its train a body of artists, artisans, literati, and priests. Their commanders, who were always liberal and well educated men, of the equestrian order, were often, like

Julius Cæsar, their own historiographers, or were accompanied by historians and poets to celebrate their achievements. In addition to the Roman and native writers, Britain furnishes in every corner of its island architectural and sculptural remains of much grandeur, whilst tesselated pavements of exquisite designs, pottery, arms, and other relics of the Roman period of British history, attest their accuracy.

The same style and taste in art, and that love of convenience, comfort, and splendour that was found in the chief provinces of Italy and Gaul, which fell short only of imperial Rome itself, pervaded the palaces of the Roman generals and the British chieftains—their coadjutors and allies; and Roman luxuries in architecture, such as hot, cold, and vapour baths, with gymnasia, hyppodromes, theatres, and amphitheatres, were to be found, as their ruins testify, in every Romano-British city or station in the island. Britain abounded at this time with well-built villages, towns, forts, and fortified stations; and the whole country was defended by that high and strong wall, with its numerous towers and intervening castles, which reached from the mouth of the river Tyne on the east, to the Solway Firth on the west.

This spirit of improvement that distinguished every spot whereon the Romans formed a settlement, so much advanced the taste and increased the number of British artists and artificers, that in the third century this island was celebrated for artistical knowledge. When Constantius, the father of Constantine the Great, was about to rebuild the city of Autun, in Gaul, in the year of Christ 296, being well acquainted with Britain, of which country his wife Helena was a native, he procured the ablest of his workmen from there, which, according to Eusebius, greatly abounded with the best artificers.

After the abandonment of Britain by the Romans—whose attention was called by insurrections against their imperial authority in states nearer home to think much of this distant colony, which had been severely ravaged by the Picts and Scots—the classical taste in architecture gradually declined, and was succeeded by various, and in some instances depraved, styles. The country, although divested of Roman armies, had been thoroughly Romanised by the enlightened conquerors; and if no Roman general or person of inferior rank remained behind, the Britons who had been intrusted with command had become half Romans by education.

The earliest city recorded to have been built by the Romans was on the site of our present metropolis, near the spot on which St. Paul's Cathedral now stands, as proved by the remains of a Roman temple discovered when digging for its foundations by Sir Christopher Wren, and others more recently found in taking down a part of old London wall, at the back of the houses on the south side of Ludgate hill. This city was founded as early as the fifteenth year of the Christian era, and was called Camelodunum; it was destroyed about eleven years afterwards by the Britons, in revenge for the cruel treatment received by Boadicea, queen of the Iceni, from the Romans. It was at that time said to have been a large and well built town, embellished with statues, temples, theatres, and other public structures. From the circumstance of this rapid destruction, perhaps by fire, it is probable the principal buildings of that city were of timber; till the time of Agricola, who finally established the dominion of the Romans in Britain, from which period may be dated the first construction of public buildings in the British capital of brick, stone, and other incombustible materials. Agricola governed the colony during the reigns of Vespasian, Titus, and Domitian, with equal courage and humanity; his residence and seat of government being the new city of Camelodunum, then as now the metropolis of the country.

These points are of some importance, as proving that the Roman style of architecture preceded every other in this island—the hut and cabin alone excepted. The Romans not only erected a great number of solid, convenient, and magnificent edifices for their own use and accommodation, but instructed, exhorted, and encouraged the Britons to imitate them.

At the time when the Saxon dominion was gaining ground in Britain, and before the disturbed times of Hengist and Horsa, public and private dwellings are related to have been constructed with strength and magnificence. In the year of our Lord 480, Ambrosius, a British commander, of Roman descent, who had assumed the regal government of Kent, built for his residence a splendid palace at Canterbury, which he made the metropolis of his small kingdom. During the Saxon heptarchy, domestic and sacred architecture continued to flourish, and buildings of both denominations were erected in the most populous parts of the seven kingdoms. The monks, who were the only architects of the times, and who travelled in fraternities from place to place, as their services were required, were a species of operative Freemasons, keeping their skill and craft within the circuit of their own lodges. In their travels they visited Rome or Roman cities, and the least skilful of them carried away the types of their art in their memories only. From their works arose the style called Saxon, which, as its earliest efforts prove, is a corruption of the Roman style—perhaps provincial, and therefore not in the purest taste,—made by memory, or rude sketches by untaught artists. The Saxon style was called by the monkish writers of those days "Opus Romanum."

The elements of the Saxon style are too well known to the readers of this Journal to need description,—but a reference to the crypt of Lastingham Priory, in Suffolk; the remains of Boxgrave Church, near Chichester, Sussex; Waltham Abbey Church, in Essex; among many other very early specimens of this style, undoubtedly well known to our archæological readers, bear witness to this hypothesis. In these examples will be found rude imitations of bad specimens of Tuscan, Ionic, and Corinthian capitals, with or without entablatures, and with or without archivolts, as seemed best suited to the architect's purpose or his erratic fancy. Bound by fewer rules than the architects of ancient Rome and Greece, the builders of these structures, by giving way to their own picturesque fancies, choosing or rejecting what they had seen at pleasure,—following however the best constructive rules, among which "*a little stronger than strong enough*" was not among the least,—they erected buildings which are still in efficient use; and created a style which is at once picturesque and, with certain effects of natural scenery, worthy the living architect's attention, from its majestic simplicity in some portions, and its singular richness of sculptural embellishments in others.

This native Anglo-Saxon style is well suited for entrance lodges on a large scale, or prospect towers appertaining to an extensive demesne, where the scenery is grand and majestic. Its preponderating, massive, and gigantic features, if well applied, accord with such purposes; particularly where the material is solid and durable, and of rather sombre hue in its *colouring* tints. A Saxon castellated entrance tower and portals of dark blue limestone, so common in the mountainous districts of North Wales and the central parts of Ireland, would form an appropriate adjunct to any of those romantic spots with which these islands abound.

As excellence is always advancing, so did architecture and its sister arts advance with varied steps in this country. Its vicissitudes may be arranged into epochs or eras in somewhat like the following manner, and will be so considered in this inquiry. Namely, from the splendour of the Augustan age—an emanation of which had reached us during the administrations of Claudius, Antoninus, and Agricola—till the declension of pure taste by the expulsion of the Romans, and the substitution of other arts, literature, and customs, formed by the association of the ancient Britons—their Saxon colleagues, which completely established the style called Saxon.

Next arrived that state of transition in which the art continued from the pure Saxon times till the rise, progress, decline, and fall of that eminently beautiful style called Gothic. This style is so varied and so expansive, that it is nearly impossible to catch it within the limits of a definition—it almost eludes description, and has occasioned more schisms among writers on art than other style of architecture extant. It has rules—but they are so discursive and ideal that no true code, like the Vitruvian or the Classical styles, has yet been formed. Some admirers of this style object to the epithet applied to it as derogatory to its importance;—but the Society of Friends scarcely ever object to the title given them originally in derision, and are not offended as being described as the people called *Quakers*. However objectionable the title may appear, it has become too general now to be altered; and the *friends* of the style are bound to receive it as an honourable distinction. Perhaps a more satisfactory title may be obtained by calling it the Anglo-Germanic style. The late Sir John Soane used to tell us students of the Royal Academy, in his lectures, emphatically that *Gothic* architecture was any thing that was not *Grecian*. Wren unfortunately called it "a gross concameration of heavy, melancholy, and monkish piles." But Wren was blind to the beautiful details of Gothic architecture, although he appreciated those of its scientific construction and its general forms, as his well known reverence for King's College Chapel, Cambridge, which he declared to be inimitable; and his clumsy imitation of York Minster in his west front of Westminster Abbey; his pseudo-Gothic of St. Mary, Aldermary; his almost beautiful imitation of Magdalen Tower, Oxford; in that of St. Michael, Cornhill, tacked by the way to a Doric interior; and his singularly beautiful spire of St. Dunstan in the East, although disfigured by Roman mouldings,—abundantly testify. Nor must the

Gothic construction of some of the concealed parts of St. Paul's Cathedral be omitted in this category of Wren's blindness to the beauty of this style, or of his willingness to be taught by such an enemy to the taste he revered. It is painful to speak thus of a man like Wren, but his fame as a mathematician, and as the greatest constructive architect that England has produced, besides his many other eminent qualities in the highest branches of learning and science, will more than counterbalance this defect, although not a small one.

An eminent living architect and writer on his art, has, on the contrary, pronounced his fiat *ex cathedra* (that is of his own chamber) that Grecian, Roman, Byzantine, or such like architecture, used in ecclesiastical edifices is Pagan and unchristian; as did Taylor the Platonist declare, in as dictatorial a manner, that all who did not believe in the religion of the Platonic school were infamous, daring, and Galilean. What says the anathematizer of Pagan and unchristian edifices, to the "Pagan and unchristian" style of the (so called) Cathedral of the Christian world, the throne of gods, vicegerent upon earth; whence in by-gone days were fulminated the anathemas of the head of the Christian church against all heretics and unbelievers? or, of any other of the Christian churches in that self called capital of the Christian world? or, of the beautiful Christian churches of Michæl Angelo, Raffaelle, Bramante, Palladio, Scamozzi, and other Christian architects of the Medicean period of Italian art,—to say nothing of the more recent Christian church, designed and executed by the catholic and tasteful Canova?

William Hazlitt justly compares the correctness and chastened rules of Grecian architecture to those of the Greek tragedians, and the elements of its style to the purity of their incomparable language. "A Doric temple," observes this discriminating critic, "differs from a Gothic cathedral, as Sophocles does from Shakspeare." The principle of the one being simplicity and harmony, governed by severe rules; that of the other richness and power directed more by fancy and taste than by too rigid an observance of scholastic discipline. The one relies on form and proportion, the other on quantity and variety, and prominence of parts. The one owes its charm to a certain union and regularity of feeling, the other adds to its effects from complexity and the combination of the greatest extreme. The Classical appeals to sense and habit, the Gothic or romantic strikes from novelty, strangeness, and contrast. Both are founded in essential and indestructible principles of human nature.

If the Gothic style be considered as a *genus* in architecture, it may be divided into three *species*:—the *robust*, the *ornate*, and the *florid*. Under the term *robust*, may be classed all the varieties of Saxon or Early British architecture; under the *ornate*, the Anglo-Norman or English; and under the *florid*, the gorgeously embellished works of the Plantagenets and Tudors, which romantic species flourished resplendently till it reached its meridian grandeur in those ages, and may date its decline from the introduction of classical literature in the reigns of Henry VIII. and Elizabeth, when Roman, or rather Italian, architecture began to mix itself with our native Saxon and British styles, as its words did with our language; and we were then, Shakspeare and Bacon excepted, pedants in both.

Various hypotheses have been formed upon the origin of this beautiful and original style. The learned German critic, Dr. Möller, principal architect to the Landgrave of Hesse, in his Essay on the Origin and Progress of Gothic Architecture, traced in and deduced from the ancient edifices of Germany, with reference to those of England; and the English Archæologist, Sir James Hall, in his profound work on the same subject, derived them from a similar source, namely:—

1. From the sacred groves or thickets of the ancient Celtic nations.
2. From huts made with the entwined branches of trees.
3. From the structure of the framing in wooden buildings.
4. From the pyramids and obelisks of Egypt.
5. From the imitation of pointed arches generated by the intersection of semicircles.

Holbein, and other painter-architects, who flourished in the last Henry, and his daughter Elizabeth, introduced the mongrel style affectedly called Elizabethan, which is neither pure nor classical, but a rambling picturesque style of shreds and patches.

Palladio, the father of that style of architecture which was introduced into England by Inigo Jones, read his Vitruvius in the true spirit of its author; and delineated restorations of ruins of ancient Rome in a purer style than perhaps existed in some of their originals. The style of domestic architecture which this great Italian master formed from his study of these splendid ruins may be gathered from the numerous Roman villas and palaces with which he studded almost every part of his native Italy. Two fine specimens of his immediate style may be gathered from Inigo Jones's adaptation of his quadrifrontal villa at Amesbury, in Wiltshire, and Lord Burlington's little gem at Chiswick, now belonging to the Duke of Devonshire; which Lord Chesterfield declared was so pretty, although not large enough for a chimney ornament, was too large for an appendage to his watch chain. Both are masterly imitations of Palladio's villa, which he erected for the Magnate Biaggio Saraceno at Vicenza, and prove, with Sir Joshua Reynolds, that skilful adaptations are not always plagiarisms.

Had Palladio's views been directed to Greece instead of Italy, and had he studied the ruins of Athens, such as they were in his time, instead of those of ancient Rome, and had delineated restorations of the Propyleïum, the Parthenon, the Theseïum, the Agora, the triple temple of Minerva Polias, and other gems of that splendid city, with Vitruvius in his mind, instead of the temples of Fortuna Virilas, of Concord, of Peace, the Theatre of Marcellus, and such like coarse imitations of the Grecian style, —or the ruins of the Greek theatres, instead of the Roman,—he would have formed a school of architecture, founded on those structures whence Vitruvius drew his rules, and as much superior to that called *Palladian* as are the works of Ictinus, Callicrates, and Phidias to the Coliseum, the Amphitheatre at Verona, the palace of Dioclesian at Spalatro, the Golden palace of Nero at Rome, and the other canons from which Palladio formed his style.

The Roman style of architecture was more successfully cultivated in England in the reigns of James I. and Charles I. than in any preceding time since the occupation of Britain by the Romans, both of whom were liberal patrons of Jones;—it perished, as did all the tasteful arts, through the fury of the Iconoclasts and Roundheads of the Commonwealth;—rose again under the fostering patronage of Charles II., who possessed some of the taste, if not the virtues, of his father;—was eclipsed by ignorance and bigotry in the reign of James II.;—and from that period till the reign of George III. a mere blank is presented in the history of the art.

Among the best specimens of our earliest domestic architecture, Hampton Court, in Herefordshire, affords a good example. It is cited, from having come nearer our times in an unaltered state than many others of like antiquity. It was erected in the reign of Richard II. (about 1380), by the Duke of Hereford, afterwards Henry IV. The mansion was thoroughly repaired, or rather restored, about a century ago, by Lord Coningesby, it having been the baronial seat of his ancestors. It contained, after the re-instatement, seven very noble apartments of state, richly furnished, and numerous convenient dwelling rooms and chambers, with suitable offices for a large retinue of servants; extensive gardens, well planted and laid out in the formal style of the times; a large park, and noble demesne; a well stocked decoy, for wild fowl; and every advantage both for pleasure and convenience.

The foreign wars, and civil commotions at home, left the English kings, nobles, and people little time for the cultivation of the Fine Arts. Therefore, no great progress was made in architecture, except in fortified residences for the aristocracy, and ecclesiastical buildings, erected or enlarged by pious devotees and profligate soldiers,—who compounded for their sins committed abroad, by erecting or endowing ecclesiastical buildings and religious services at home, for the good of their souls. This state of foreign warfare and domestic insecurity continued during the reigns of the fourth, fifth, and sixth Henries, till the successful establishment of the Earl of Richmond as Henry VII. gave security and much-required peace to the country. Before the time of Richard III., however, Crosby Hall, which has been recently beautifully restored, was erected; it is a splendid specimen of this style, and was in its day a sumptuous metropolitan residence. The same golden age of English architecture produced that delightful miracle of tasteful and scientific construction—King's College Chapel, Cambridge; and other sacred edifices, that do honour to their authors. Henry VII. completed what may be considered the perfection of the Florid style in his mausoleum at Westminster, now called Henry VII. Chapel,—and brought over to this country Tortegiaus, the rival and combatant of Michæl Angelo, to execute his magnificent tomb of bronze, for the reception of his mortal remains.

The mixed anomolous style that was introduced into England after the sun of the Tudor style had set, by ornamental and scenic painters from Flanders and other parts of the Low Countries, obtained the patronage of the rich for fashion sake, and in imitation of the bad taste of the court from the middle of the reign of Henry VIII. till the time of James I., Holbein, Zucchero, and their royal mistress, Elizabeth, may be esteemed its sponsors; and it revelled in bold misrepresentations of Palladian purity, grafted upon a Flemish stalk; and abounded in orders upon

orders, bows, niches, grotesque imagery, and foliage—"gorgons and hydras and chimeras dire," thrown about with all the redundancy of pictorial wantonness;—half-timbered houses of divers colours; "black spirits and white, blue spirits and grey," grinning horrible defiance to good taste, in this pedantic style, which alike infested our language and our architecture. It closed—to show what height architectural absurdity may reach—in the portal entrance of the schools at Oxford, where the five orders of Italian architecture, caricatured in the worst taste, are piled one upon the other—the brawny Tuscan at the bottom, almost crushed by the superincumbent weight, and the lanky Composite at the top.

This aberration—for style it cannot properly be called—thanks be to the improved taste acquired by Prince Charles and his gay companions, who rubbed off their pedantic rust by continental travel, a better style in art prevailed;—Vandyke superseded Holbein, substituting nature for dry affectation; and Jones threw the nameless and irresponsible architects of the monstrosities of the Elizabethan period into that obscurity which all the endeavours of the elegant pencils of modern draughtsmen have not been able to revive.

The Roman or Italian style of architecture, adapted to domestic economy, was first introduced with classical purity into this country by Inigo Jones, who flourished in the reigns of James I. and his son Charles; and died neglected in the tasteless times that succeeded the beheading of his royal patron. The most distinguished works of this eminent English architect, are the before-mentioned mansion at Amesbury, in Wiltshire; that on the northern side of Greenwich park, which now forms the central building to the Royal Naval School; and at the same time, an appropriate centre to the Royal Hospital as viewed from the river; Shaftsbury House, in Aldersgate-street, formerly the town mansion of the nobleman of that name, and now subdivided into a series of shops and the establishment of the General Dispensary; some town houses on the southern side of Long-acre, the pilasters and Corinthian capitals of which are still in existence; some mansions on the west side of the square called Lincoln's-inn-fields, the ground plot of which he set out the same size as the large Egyptian pyramid; and the grand piazza of Covent Garden, which is fast disappearing under the hands of the building innovators. Among his most celebrated town mansions, may be mentioned that of the Duke of Bedford, on the north side of Bloomsbury-square, which, with its gardens and pleasure grounds, occupied the whole areas of Russell and Tavistock squares, almost up to the New road. It was taken down to make way for the profitable improvements by building speculators of that brown brick suburb of the metropolis. It was a perfect Italian villa, carefully adapted to our climate, and contained among its state apartments an extensive picture gallery. Among its pictures was that fine set of copies from the cartoons of Raffaelle, made on canvas in turpentine colours by Sir James Thornhill, and presented by Francis, Duke of Bedford, to our Royal Academy of Arts.

For the satisfaction of such of our architects who have not yet learned to despise old "Iniquity Jones," as Ben Jonson called him in one of his satires, Harcourt House, on the west side of Cavendish-square, still remains in almost its pure pristine state, for their contemplation. But let them be quick about it, for it has already been looked at by the architect of an innovating Joint Stock company, for the purpose of converting it into a series of club chambers, like those of the Albany, Piccadilly. It is not an upholsterer's mansion—all carpeting, flock papering, gilt papier maché, and gewgaws; but a solid substantial structure, of sound brick and stone, marble sculptures, and fine oak carvings; built for ages and for the occupation of a noble English family, who could boast, like the Italian notables, that it was built by their ancestors, generations ago, and had never been occupied but by their own race. The noble founder, to do justice to his architect, has placed his bust in a conspicuous part of the principal front.

Among his works that are still extant is the Dormitory, at Westminster School; its exterior is strongly marked by the prevailing character of his style—a correct manly simplicity, and a just proportion of the component parts characteristic of its use; the interior of the upper story is well enough for the use of the scions of aristocracy who occupy it, and is annually used as the theatre for the performance of the Latin plays by the Westminster scholars.

In enumerating the works of Inigo Jones, his vast and splendid portico to the old cathedral of St. Paul, that was destroyed by the great fire of London, must not be forgotten. Its proportions and dimensions may be seen in Kent's publication of his works; but the vastness and grandeur of this stupendous portico, so far superior to any other in England, and perhaps in Europe, can be better imagined than described. Of the propriety of adding a Roman portico to a Gothic cathedral, much cannot be said; but perhaps the architect contemplated the completion of a Christian cathedral in a similar style with his portico. It has been compared to a pension given by a profligate king to a parasitical favourite, as being a good thing ill applied. Lord Burlington said of it, on viewing the new cathedral—"When the Jews saw the second temple they wept."

These works, and some unexecuted designs, published by Kent at the expense of the Earl of Burlington, show the fertility of this architect's mind, and the skill with which he adapted the best styles of Roman architecture to the domestic conveniences required by an English family in our variable climate. His church of St. Paul, Covent Garden, which he built for the parsimonious Duke of Bedford, who desired a mere barn for the use of his Covent Garden tenants, and was informed his desire should be complied with it, but it should be the finest barn in Europe, also shows the dexterity with which Jones could use the plainest materials. It produced the desired effect, and stands alone as a masterpiece of Frudal architecture, proving how the mind of a man of genius can overcome difficulties. It is the only specimen of the true Vitruvian Tuscan ever known to have been executed. The late Mr. Hardwick displayed becoming reverence for the master mind of his great predecessor, by attempting no improvements upon this singular example of church architecture, when he repaired it after a destructive fire.

Heriot's Hospital, near Edinburgh, an early work of this architect, before he had matured his taste by foreign travel and the study of the great Italian masters, has little to recommend it, excepting the simplicity and aptitude of the plan to its purpose. The architectural world is indebted to Mr. Goldicutt for some tasteful etchings of the plan and details of this building. The only other work of Jones in Gothic architecture is the Chapel in Lincoln's inn, and proves that neither he nor Wren comprehended the spirit of this beautiful style.

His greatest work, however, was the magnificent palace which he designed for James I., the Banquetting House, Whitehall, now used as a military chapel, being the only part executed. It was to have covered an immense plot of ground, extending from Charing-cross on the north, to Richmond-buildings, Parliament-street, on the south; and from the river on the east, to the Parade in St. James's-park on the west. Four such buildings as the present chapel were designed: one opposite to it, near the site of Melbourne House; the other two, one in a line with it, near Scotland-yard, and the other opposite thereto, on the site of the Admiralty,—and were to be used as a banquetting room, a royal chapel, a throne-room, and a hall of audience. They were to be connected by a variety of state and domestic apartments, official residences, spacious courts for air and light, and every accommodation for a royal palace, suited for the greatest monarch in Europe. The circular court surrounded by an arcade supported by statues, thence called the court of the Caryatides, was one of the finest conceptions that ever emanated from the mind of any architect—ancient or modern. The whole design, which, thanks to the liberality of the great Earl of Burlington, has been published, with numerous and ample details of all its parts, is a perfect school in itself for an architectural student: the masterly skill with which the architect has conquered the difficult arrangements of the state and private apartments, without unnecessary interference with each other,—the manner in which he has arranged the various courts for light and air,—and the underground apartments for domestic use,—and complete drainage necessary for the salubrity of such a vast assemblage of buildings, combined with consummate skill into one perfect whole, should form, with his mansions and villas, the study of every aspirant to architectural honours. These works of Inigo Jones would alone furnish a series of lectures on the skilful adaptation of architectural grandeur to domestic comfort and internal convenience, worthy the talents of the greatest master of the present day. This great English architect and his worthy successor, Sir Christopher Wren, are, to our national disgrace, better understood and more highly appreciated in France and Germany than in their native England.

The only executed portion of this magnificent design—namely, the military chapel or banquetting house—is, like the part from which it is detached, grand in style, but unequal in some of its less important details. The conception of which, considered as the small part of a mighty whole, is in itself noble; its primary divisions are few and simple; its openings large and handsome;—but as a whole it is unequal in composition and in style. The play of light and shade produced by the breaks over each column is, in a minute taste, the very opposite to grand. The Ionic specimen—the invention of which is attributed to Scamozzi, but is really a

corruption of the angular capitals of the temple of Minerva Polias—is one of the worst and the most impure that he could have selected; the modillions do not belong to the order, and approach too nearly to those of the Corinthian. If one order upon another be ever admissible, the Corinthian should not have been excluded for the purpose of introducing the Composite.

ON THE SCREW PROPELLER.

In the following paper we propose to examine theoretically the best angle for the worm of the screw-propeller—taking for granted the theoretical formulæ for the resistance of fluids. At some future opportunity, we propose to investigate the problem in a more practical manner, and to supply conditions for the best form of the screw itself, with reference to strength and useful effect.

Let B E D be a small plane rectangular lamina of rigid matter, attached by means of a rigid rod A B, without weight, to an axis A L, which is horizontal, and about which the rod A B can revolve in a vertical plane. Let the rod A B be in the plane E B D and perpendicular to the side E C D; also, let the small lamina E B D make an $\angle\ \theta$ with the vertical plane in which A B rotates; and let the area of the plane E B D $= k$.

If the axis A L be fixed to a vessel floating in water or any other fluid, and the point A be at such a depth below the surface that E B D will always be in the fluid, and A B be made to revolve rapidly in the direction C d,—the resistance of the fluid upon B E D, resolved in a direction parallel to A L, will cause the vessel to move in the direction A L.

Now, the worm of a screw, having A L for its axis (the plane of any element of the worm being supposed to contain the line A B), may be supposed to be made up of an infinite number of small elements, similar to E B D. The rotation of such a screw would, therefore, cause the vessel to move through the water. If the propulsion were caused not by one unbroken worm, but by several portions of the same worm, symmetrically and oppositely disposed about the axis, the resolved parts of the resistances perpendicular to the axis will destroy each other, and the motion of the vessel will be steady and in a straight line. When the vessel is moving with an uniform velocity, the resistance of the water to its motion will exactly equal the resistance to the screw, resolved in the same direction; and the sum of the moments of these two resistances about the centre of gravity of the vessel will be zero.

To return to the consideration of the single element E B D, supposing the vessel moved has a velocity v, and the resistance to its motion is R, let us determine the value of the $\angle\ \theta$, when the amount of moving power expended is a minimum. Let ρ be the density of the fluid; r = distance A B; m the angular velocity of E B D. Let Fr be the moment of the pressure about A L, E B D exerts when moving with an angular velocity 1; then, if the moving power be constant, $\frac{Fr}{m}$* will be the moment of the pressure exerted by E B D when moving with an angular velocity m. Consequently, the resolved part of the velocity of E B D perpendicular to E B D is $(m r \sin.\theta - v \cos.\theta)$; and the resistance against E B D $\frac{1}{2}\rho k \left\{m r \sin.\theta - v \cos.\theta\right\}^2$; B C being supposed indefinitely short compared with A B.

The resolved part of the resistance parallel to A L is

$$\frac{1}{2}\rho k \left\{m r \sin.\theta - v \cos.\theta\right\}^2 \cos.\theta = \mathrm{R},$$

since v, the velocity of the vessel, is by hypothesis uniform. Also, since the motion of A B is uniform,

$$\frac{1}{2}\rho k \left\{m r \sin.\theta - v \cos.\theta\right\}^2 . \sin.\theta \times r = \frac{Fr}{m};$$

$$\therefore \frac{Rm}{F} = \cot.\theta; \quad \therefore m = \frac{F}{R}\cot\theta;$$

$$\therefore \frac{Fr}{R} \cdot \cos.\theta - v \cos.\theta\Big\}^2 . \cos.\theta = R;$$

$$\therefore Fr = Rv + \sqrt{\frac{2R^3}{\rho k . (\cos.\theta)^3}}.$$

In this expression, it is clear that F is least when cos. θ is greatest—that is, when cos. $\theta = 1$, and $\therefore m = \alpha$. The interpretation of this apparently paradoxical result shows that the smaller the angle of the worm of the screw, the less is the power lost in transferring motion to the vessel. There are, however, certain practical considerations which cannot be neglected in determining the best value for θ. In the first place, we have supposed the lamina E B D to be indefinitely thin, and that all the resistance is perpendicular to E B D; this, in practice, is not the case:—the resistance against E B D being very considerable, it follows that—in order for the material connection of E B D with A L not to be destroyed by so great a strain—E B D must be of appreciable thickness.

Let the area of edge of E C B $= h$; then neglecting the effect of the mass of E B D and its weight, we should have the following equations:

$\frac{1}{2}\rho k \left\{mr \sin.\theta - v \cos.\theta\right\}^2 \cos.\theta - \frac{1}{2}\rho h \left\{mr \cos.\theta + v \sin.\theta\right\}^2 \sin.\theta = R$

and, $\frac{1}{2}\rho k \left\{mr \sin.\theta - v \cos.\theta\right\}^2 \sin.\theta + \frac{1}{2}\rho h \left(mr \cos.\theta + v \sin.\theta\right)^2 \cos.\theta = \frac{F}{m}$

In these expressions we find that R is diminished, while F is increased; consequently, there is a double loss of power. F must be increased to balance a resistance which not only does not accelerate, but actually retards, the motion. Also, the new terms introduced rapidly increase by diminishing θ: a value of $\theta = 20°$ would probably make F nearly a minimum.

The whole theory of resistances is, however, so little to be depended upon, that the results we have obtained can only be regarded as a rough method of approximating to the truth. In a future number of the Journal we hope to be able to continue the subject, founding our investigations on data of observation and experiment.

[In the number for April, in the article "On the Motion of Fluids," p. 98, for "the equal number for v,"—read, "the equations for v;" and, p. 98, col. 2, for the "mean vertical velocity of the particles,"—read "the mean velocity of the particles in direction of the tube."]

SEWAGE AND DRAINAGE.

Since our last number, we have seen with the deepest regret, that the Government have agreed to leave out from their sanitary measures for the present year the metropolitan districts. It is most painful to reflect that two millions are left exposed to the evils of a most inefficient system of sanitary administration, at a time when the scarcity of food is sure to produce severe disease, and when there is every likelihood of the Asiatic cholera spreading through Europe to this country.

If there be one fact that admits of no doubt in the public mind, and of no doubt in the minds of any but aldermen and commissioners of sewers, it is that the sanitary administration of the metropolis is most shamefully misconducted, while it is imperative that the administration should be concentrated and carried on with vigour. Whatever superiority we may have over other countries in such matters, it is nevertheless true that we are miserably behind-hand, so far as our own enlightenment is concerned. We want no facts to prove this beyond the experience of every individual, though the reports of the Registrar-General and of the officers of sewers are convincing.

One great good we expect from the abolition of the present system—or no system—is full scope for the exertions of able and intelligent engineers and surveyors. Indeed, it is by such only that any amendment has been effected, as the labours of Mr. Roe, in the Finsbury Division, and lately of Mr. Phillips, in the Westminster Division, fully show. We have now before us a report of the latter gentleman, to which we shall direct attention in preference to any other branch of evidence.

This report is produced in pursuance of an order of the commissioners of sewers, on the 1st May, 1846, and ordered to be printed 16th April last, to ascertain the condition of a part of the eastern division of the sewers north of Oxford-street, and east of Portland-place and Regent-street. This district (called All Souls) contains an area of about 130 acres, with a population of 27,000 persons residing in 3000 tenements. The density of the population is not great, considering the extent of the district and the number of houses inhabited—being on an average nine persons to each house. Mr.

* We here suppose that no part of the power of the engine is expended in overcoming the friction and resistance to motion of its several parts.

Phillips says, that the situation of this district, although not quite so airy and salubrious as others in the parish of St. Marylebone, is far from being close and unhealthy. The houses generally are large, being chiefly third-rate, and narrow streets, courts, and alleys are not numerous. The streets indeed are most of fair width, running in straight lines north and south, and east and west, and communicating with other wide streets running in those directions; and having therefore currents of air running freely through them, and keeping up good ventilation. The district is, further, seventy-four to eighty-three feet above the level of Trinity high-water datum in the Thames. The paving is generally in good condition; and being well supplied with gully drains, the surface water is carried off speedily. Nearly all the public ways have sewers running under them.

The above description appears to be that of a healthy and comfortable district, but Mr. Phillips gives full proof of its real state, and of the operating causes. He contrasts it with the neighbouring district of Cavendish-square, and he finds from the return of the Registrar-General in 1845, that whereas in Cavendish-square the mortality was one in fifty-nine, in All Souls it was one in twenty-eight, or more than twice as great. The rate of mortality per hundred stands thus—

Cavendish-square	..	..	1·7
All Souls	..	..	3·6
Excess on latter	..	..	1·9

The excess of mortality in All Souls district is more than equivalent to that of a healthy district; so that, literally and truly, the Cavendish-square people have twice the health of those of All Souls. The number of persons murdered in All Souls district cannot be calculated at less than 200 persons yearly, whereas it is very likely 500. The average per centage of mortality in the parish of St. Marylebone is one in forty-four, or 2·27 per hundred, which average, of course, is made up by such districts as those of All Souls. The fact that the population of All Souls is of a poorer class than that of Cavendish-square, is not enough to account for the greater mortality of 520 persons yearly, or 10 weekly.

The cause of this wholesale murder is the neglect of the sewers by the Westminster commissioners. The sewers appear to have been built between seventy and a hundred years ago, and are all built with flat paved bottoms and upright sides, spanned by half-round arches. They vary from 4 feet to 5 ft. 6 in. in height, and from 3 feet to 4 feet in width—being of ample size; but all the junctions are formed at right angles, many of them being broken through the side walls and not made good. The materials used in their construction are the worst of their respective kinds, being place bricks, and mortar composed of chalk lime and loamy pit sand. They are now, Mr. Phillips says, "very much dilapidated, considerable lengths of the side walls being now in ruins, and the remainder falling fast to decay."

As a fit appendix to this, Mr. Phillips states that—"It would appear the court of sewers exercised little or no authority over either the arrangement or construction of these old sewers; as the only record respecting them that I can discover in this office, is the report of a committee, on view in August, 1786, stating that the side wall of a sewer at the north end of Norton street had bulged for a length of ten feet; that the sewer at the north end of Titchfield-street had been built with place bricks, that the arch had fallen in in several places, and that a great quantity of rubbish was in the sewer." Thus, what the sewers were sixty years ago they are now; and during that period, at least, their neglect by the commissioners has been consistent—which is the most corteous term we can employ. We cannot, however, find that the inhabitants have been exempted during that time from sewers rates—that would be too much to expect. Indeed, when we look at the further evidence, we cannot but think that the inhabitants would have been better without sewers, and that they only paid for being poisoned. In Lisbon, and other unhealthy cities, they have no sewers—and yet the mortality is not higher than in All Souls, Marylebone, where the sewers can only be regarded as what Mr. Phillips in one place calls long and narrow cesspools.

Mr. Phillips informs us, that for many years past, the inhabitants have complained of these sewers being choked up and stopping their drains, and of noxious exhalations arising in the streets and houses, and that they still continue to do so. Mr. Phillips confirms these complaints—having, in order to acquaint himself with the extent of the evils, on numerous occasions passed through the sewers. In doing this, he waded and crawled, sometimes in darkness, through vast accumulations of half-fluid black matter, and his health suffered greatly in consequence.

It seems, that from 1834 to 1844, 185,058 cubic feet of soil or poison were taken out of the sewers, and carted away, at an average annual cost of £118 9s.,—besides contingencies, which perhaps doubled the outlay. The relief, however, was but temporary, and the disbursement of this trumpery pittance did not abate the evils.

These sewers are described as containing, throughout, an immense accumulation of detritus and decayed animal and vegetable matter; and they are thus becoming worse every day. From their bottoms being flat and broad, and the fall but little, and that irregular, directly they are cleansed they begin choking up again. This, Mr. Phillips says, goes on increasing backwards, until the surface of the soil forms an artificial fall, whereby the water gains sufficient force to prevent any further deposit from taking place. This is in obedience to a natural and well-known law, and it illustrates the futility of laying down sewers with too little fall—for if the fall be not given to them, they will make it for themselves. On account of this "grading," as the Yankees call it, of the main sewers, the soil in many of them is now on a level with, and in others it is above, the mouths of the house drains, which are in consequence fast choking up, many being stopped already. This is the state of affairs in a large and wealthy parish, paying a large sum to the sewers rates—and certainly willing to pay for health and life.

The house drainage, as may be expected, is most defective. Cesspools and common privies abound. Some of the cesspools have no overflow-drains, so that the more flowing portion of the matter soaks away through the neighbouring ground, choking it with filth, and leaving the solid matter to rot. Those having overflow drains are always full of soil, and send forth such pestilential exhalations as almost, in many instances, to prevent any one from going near the privies. The side drains from the houses are large, and have flat bottoms, so that the small quantity of water flowing from the houses cannot keep them washed out; and they consequently choke up, requiring often to be broken into so that they may be cleansed —thereby causing outlay and annoyance. As often, however, as they are cleaned, voids are formed, which are again and again filled up.

Mr. Phillips, we are glad to see, agrees that it is needful that house drainage should be a part of the entire sewerage,—and says that "the sooner the legislature place house drainage and sewerage under the same control, the speedier will be the removal of many and glaring evils. A skilful combination into one system of house and street drainage, conjointly with a full and efficient supply of water, would ensure the removal of filth and waste water into the sewers, nearly as fast as produced, instead of being detained as at present in the drains and cesspools in and about the houses, for months and years together." Certainly until this is done, nothing is done; and uniform sewerage is quite as important as uniform postage. To the wealthy, it is essential that the houses of the poor should be drained, for in them are the great seats of fever and disease;—sewerage is not a luxury for an individual, but a duty towards the community; and as the expenses of communicating with sewers are about the same in the case of a poor house as of a wealthy house, none would demur on the whole charge being thrown upon property.

The cleansing of the sewers in All Souls district would require the removal of 50,000 cubic feet of soil—and then only temporary and inadequate relief would be obtained. The sewers are, indeed, in such a shameful condition, as is well known to the officers and workmen employed, that when called upon to make examinations and to work in them, they show great dislike, from the feeling of danger they have. They are fearful when entering them, at every step they take, of setting fire either to explosive gases generated from the soil or escaped from the gas mains in the streets, or of being overpowered by the heat and foulness of the atmosphere, "which, from want of ventilation, causes great dimness of sight, giddiness, and sweating, and also makes breathing very oppressive, as from experience I can testify," says Mr. Phillips. It is right to observe, that the parish and other authorities have complained of such a state of affairs.

Some curious illustrations of the vigorous administration of the commissioners are given incidentally. The great sewer in London-street was rebuilt in 1828, nearly twenty years ago, more than two feet lower than the present one in Cleveland-street, in anticipation of the line of outfall being lowered—and it now contains an accumulation of soil nearly four feet in depth. The sewer in Newman-passage was likewise rebuilt in 1829, between two and three feet below that in Newman-street, for a like reason, and is so full of soil that parties who have obtained leave to lay drains into it have been unable to do so!

Mr. Phillips justly observes, that no temporary expedient can be applied in such a state of affairs, and he proposes to rebuild all the sewers and to

improve the outfall through the main Hartshorn-lane sewer by a work of considerable labour, which will need 1,300 feet of tunnelling. Upon this, we cannot help observing, as we did last month, that it is really a pity to see the waste of money and the inefficient measures, which are the result of the present system. We then pointed out that a large sewer, belonging to the Regent's-park and Regent-street commission, runs through the centre of the Westminster district; and yet, that for the latter, distinct outfalls are sought and the channels constructed, at an enormous expense. If an arrangement were now entered into between the two commissions, for the purpose of allowing the sewers in the vicinity of Regent-street to communicate with the Regent-street sewer, a vast outlay would be saved in rebuilding the sewers, no doubt, by partly raising and partly lowering the bottom of all the sewers on each side of Regent-street, to the distance of 500 yards. The accumulation of the filth in those sewers might be got rid of, particularly if a new bottom were made to the sewers of a circular shape; in fact, this latter arrangement could be done to most of the old square-built sewers.

In the present case, Mr. Phillips canvasses the propriety of communicating with the King's College Pond sewer; but he says not one word of the Regent-street sewer, which runs through his district. The drainage of Devonshire-street, which lies on the latter sewer, is therefore proposed to be carried through several bends and at right angles, down to Broad-street, Bloomsbury, a distance of many thousand feet—when the Regent-street sewer can be entered at the bottom of Devonshire-street. We say nothing as to the necessity for improving the Hartshorn-lane sewer and outfall; but we do urge, so far as the streets in the neighbourhood of the Regent-street sewer are concerned, that the Westminster Commissioners should have a conference with the Commissioners of Woods and Forests, and come to some arrangement.

Mr. Phillips estimates that his plan will require the rebuilding of 25,176 feet of sewer, at a cost of £20,140 16s.; but he does not dare to recommend the immediate execution of his plan and the disbursement of this sum,—but proposes, as a first instalment, the outlay of £4,057. Supposing this to be one year's outlay, and that the saving of human life should be in proportion to the average of Cavendish-square, and to the gradual extension of the sewers,—the number of persons destroyed during the gradual execution of the plan would not be much more than 1,539, or the population of a good sized market-town; whereas, by the immediate disbursement of about £13 a-head, the destruction of so many human beings might be averted. Supposing the money borrowed at 3 per cent., for the purpose of making the immediate outlay, the additional charge for this would be about thirty shillings per head on the whole number of individuals proposed to be murdered. Perhaps the Humane Society, or some other Society, might think it worth while to advance the money as a gift, and thereby save so many human lives.

The public have been greatly scandalised by the promulgation of the fact, that the mortality in parts of Whitechapel and the eastern districts is 1 in 24 yearly;—but we believe they were not prepared for a mortality of 1 in 27 in Marylebone—and that mortality, as a public officer has shown, caused by the shameful state of the sewers alone. It is in the presence of such facts, that Lord Morpeth has taken on himself the responsibility of withdrawing that measure of legislative relief, to which the inhabitants of the metropolis have so long looked forward; and he has thereby taken the further responsibility of sanctioning a system of administration which the medical profession, the engineers, and the press have justly pronounced a system of wilful murder.

After the engineering profession have so long exerted themselves for the improvement of the state of the metropolis, it is quite disheartening that they should be deserted by the minister of the department which professes to take charge of the subject. So long as there was a prospect of a Government job in employing military engineers to make a metropolitan survey, to superintend civil works, and to receive the emoluments of civilians, the government were zealous enough; but when this inducement is taken away, the commissioners of sewers are allowed any reprieve they choose to claim.

If the removal of the filth of the metropolis be an important object, the saving of the valuable manure which is now wasted is no less deserving of consideration: but we are afraid this also is likely to meet with the fate of other measures of improvement. The Metropolitan Sewage Manure Company have this session applied for a new act to enable them to lay down a receiving sewer, which shall cut the sewers at a mean distance of 620 yards from the river, involving very expensive works. To this, Mr. John Martin, the founder of the company, objects,—and proposes an alternative plan, for receiving the contents of the sewers near their outfall, which certainly appears the more rational plan—and we can conceive, from such evidence as we have before us, no reasons for the company's plan. 620 feet would be a great distance from the river, but 620 yards seems monstrous—for thereby the large intervening district is left unwrought.

We may here observe, that we look upon the useful application of the manure of towns as a great boon, which engineering knowledge will confer upon the tillage of this island. From a town population of four millions, and with the great body of horses employed by them, a quantity of valuable manure is obtained, which cannot be reckoned at less than equivalent to the production of half-a-million of quarters of corn yearly, or the yearly food of half-a-million of human beings. When it is considered how the refuse of the dustyards of London is economised, it is strange that the produce of the sewers should be wasted. The old metals, the broken pots and pans, called pickings, the rags, bones, cinders, small coal of the dust bins, are all saleable; the produce of the cesspools is made a lucrative branch of business, and manures are made from it in London which are sent out even to the sugar plantations in the West Indies—but the greater part of the manure of the metropolis is sent into the Thames to pollute its waters.

MEASURES OF FORCE AND LAWS OF MOTION.

SIR—In your last number, you state (page 129) that—"If when a body is in motion, it be acted upon by an invariable force, in the direction of its motion, the quantity by which the velocity of the body will be increased or diminished (according as the force is accelerating or retarding,) will always be the same in the same time; and is quite independent of the initial velocity which the body possessed before it was subject to the influence of the force." Further—

"This fact at once furnishes us with a convenient dynamical measure of force, known by the name of the measure of accelerating force." . . . "Thus gravity accelerates the velocity of a body falling in vacuo by $32\frac{1}{6}$ feet a second; taking feet and seconds as units of space and time, the accelerating force of gravity is represented by $32\frac{1}{6}$."—This is all perfectly true; but there is considerable danger of an erroneous inference of great practical importance being drawn from it, which it is well to guard against.

Suppose a heavy body to fall from a height so as to occupy several seconds in falling; the effects may be tabulated thus:

Seconds occupied in falling.	Space fallen through in each second.	Total space fallen through by the end of each second.	Acceleration during each second.
	Feet.	Feet.	Ft. Ft.
1	16	16	from 0 to 32 = 32
2	48	64	from 32 to 64 = 32
3	80	144	from 64 to 96 = 32
4	112	256	from 96 to 128 = 32

Now, as the amount of *acceleration* communicated to the falling body by gravity in any one second is precisely equal to the amount so communicated in any and every other second, an unguarded reader may easily fall into the error of supposing that the amount of *gravitating force* expended (if I may so term it) upon the falling body in any one second is, in like manner, precisely equal to the amount so expended in any other second.

In fact, not only unguarded readers, but also very able writers, appear to have fallen into this error; imbodying it in the untrue doctrine, that the momentum* of a moving body is as its weight (or mass) multiplied by its velocity. The truth being that the momentum is as the weight multiplied by the square of the velocity; a truth of the greatest importance in questions concerning the effects of hammers, fly-wheels, ordnance, &c., and of winds, waves, and currents of water,—the resistance of water to the passage of vessels, &c.

If it be necessary to prove this truth, a mere inspection of the foregoing table is enough, as respects falling bodies; for it is therein seen that while a fall of 16 feet produces the velocity of 32 feet per second, a fall of 64 feet, that is four times the fall, only produces double velocity; nine times the

* Perhaps the real difference may lie in our differently understanding the word momentum. My understanding of the term is at least a practical one, viz.: that it means the amount of power which can be communicated to a body by putting it in motion, and which can be taken back from it by stopping its motion; this amount of power being measured in the manner in which the animal power, mill power, &c., are ordinarily measured.

fall = 144 feet, only triples the velocity; sixteen times the fall, or 256 feet, produces only a four-fold velocity, &c.

As to other moving bodies, Smeaton's experiments upon flies, prove beyond all doubt, that they are subject to the same laws—viz.: that to *double* the speed of a given fly, requires the expenditure of *four times the power*, which produced the original speed; while to triple the original speed, requires the expenditure of nine times the original power, &c.

Subsequent experiments have shown that a fly, running round at a given speed, produced four times the effect (in rolling long strips of lead) which it would produce at half the speed; nine times the effect it would produce at a third of the speed, &c. In short, if we take units of *time*, and subject a body to the action of an invariable impressed force during one, two, three, four, &c. of such portion of *time*, we shall find that the spaces traversed by such body in these times will be as the squares of the numbers denoting such times. While, if we take units of *space*, and subject a body to the action of an invariable impressed force, while it moves through one, two three, four, &c. of such portion of *space*, we shall find that the times occupied by such body in traversing such spaces will be as the square roots of the numbers denoting such spaces.

In relation to mechanics, I think that the correct mode of measuring force is that last-named—viz.: to take the *space* through which a given pressure acts, as the measure of the force expended; because all power which is under our control, is naturally so measured.

To wind up a given weight, 16 feet, requires a given power p, whether animal or mill power, and whether the weight be wound up slowly or with moderate rapidity. Release the weight and it falls in one second of time, obtaining an acceleration of 32 feet per second, which call a.

To wind up a like weight 64 feet requires $4p$; release it and it falls in two seconds, obtaining an acceleration of $2a$ only.

A like weight wound up 144 feet requires $9p$, and will fall in 3 seconds, obtaining $3a$ only of acceleration.

The time occupied in the fall of the weights being respectively 1, 2, and 3, and the amount of acceleration being also respectively 1, 2, and 3, while the power expended in raising the weights is respectively as 1, 4, and 9, it is clear that neither the time nor the acceleration affords a measure convenient for mechanical purposes; but the *spaces* traversed, viz.: 16 feet, 64 feet, and 144 feet, are in the same proportions of 1, 4, and 9, as the respective quanties of power expended; therefore, the length of the space traversed by a body while acted upon by a given power is the true measure of the power expended by the mover; and with a freely moving body it is also the true measure of the force which is absorbed by such body, and which that body will discharge upon any obstacle which shall stop its progress. A falling body, for instance, must discharge upon the earth just the power expended in winding it up; and it is obvious that this *charge* and *discharge* (if I may so term it), can be repeated at pleasure, and that the power first communicated and then discharged is precisely measured by the vertical space through which the weight is first raised and then allowed to fall.

A hammer of a given weight being wielded with double speed will strike four times as hard a blow.

A bullet being shot off with triple velocity will penetrate with nine times the force.

An engineer wishing to quadruple the power of his fly may either procure a wheel four times as heavy, retaining the present speed, or he may double the speed of his present fly without adding to its weight; in either case, his object will be equally attained.

Upon a future occasion, I propose to adduce instances in which the want of attention to these principles has occasioned lamentable waste of valuable time, exertion, and of money.

I am, Sir, your obedient servant,

E. Hill.

[We have much pleasure in acknowledging the receipt of the above letter, from Mr. E. Hill, in which, as will be seen, the writer animadverts on certain statements and definitions given by us in a paper "On the Laws of Motion," that appeared in a late number of the Journal. In reply to the objections urged by Mr. Hill, we beg again to state that momentum is a term used to denote the product of the mass and velocity of a body; and, moreover, that there is no doctrine involved in it. It is an arbitrary technical expression, and to object to its signification is to dispute about words—not about principles. Mr. Hill evidently confounds momentum with what is called by engineers "power expended," or sometimes "work done"—which no doubt varies as the square of the velocity, as we will immediately show:

Let m be the mass of a body caused to move from rest by a pressure which is X, at the distance x: then if v be the velocity acquired at the distance x, we shall have $mvdv = X\,dx$, by the equations of motion.

$$\text{Consequently, } \frac{mv^2}{2} = \int^{0-x} X\,dx;$$

but $\int^{0-x} X\,dx$ is the "work done"—which, therefore, varies as the square of the velocity. There is considerable confusion manifested by Mr. Hill in the use of the word "force": he talks of a bullet penetrating with nine times the force, instead of nine times as far;—in this instance, Mr. Hill uses "force" to mean what he misconceives by the term "momentum"—viz., $\int X\,dx$, or "power expended." We are sorrowfully willing to concede, that much time and money have been wasted in engineering matters—not, however, as Mr. Hill would insinuate, from a too rigid regard for the laws of motion and measures of force, but from gross ignorance of both. Unfortunately, the confused ideas of men unacquainted with mechanical principles, by jumbling together force and its effects, and giving birth to vague and useless terms, such as "living force"—and "power expended"—and "power absorbed," and the like—have done considerable mischief to the science of engineering, by divesting it of its simplicity, and basing it upon anything rather than what it ought to be based upon—namely, the six equations of statical equilibrium, and the six dynamical equations of motion.]

ARMY AND NAVY CLUB.

We do not think it needful to make any lengthened remarks on the competition of designs for the Army and Navy Club, or to enter into any detail with regard to them, as the designs were, according to our views, far below the proper standard, and we are glad to perceive that the Committee have had the good sense not to carry out those which received the prizes. So far as the competitors were concerned, the whole affair must be considered highly derogatory from them, for they came before an irresponsible tribunal, they subjected themselves to the consequences of a ballot, and they resorted to canvassing—some of them, we believe, sending round bills and testimonials, like the Morrison's pills or Holloway's ointment sellers. It is in perfect keeping with these proceedings, that some competitors resorted to false perspective views and other tricks to catch the unitiated. Thus ended the lottery at the Army and Navy, or Derby, Club, with the loss of time and money to between sixty and seventy architects.

Prudent men among the architectural profession of course refrained from engaging in a competition which depended upon the votes of a number of members of a miscellaneous club, passed through the dark ordeal of the ballotting box. The Committee Club, we presume, indulged the members in this mock election, as the cheapest way of getting rid of the clamour of those ultra members, who are sticklers in principle for competition and vote by ballot, because of course it could have only one result—the utter impossibility of getting a good and feasible design. A first rate competition is not to be got by such haphazard proceedings, for neither old men of talent, or young men of talent, like to expose themselves to the chances of defeat before an incompetent tribunal, while they are really to afford at their own expense the materials of their own overthrow. A painting executed in competition for a prize, if unsuccessful in gaining the prize, may be exhibited and sold elsewhere; but a design for a club, which has cost weeks of labour and entailed much expense, cannot be réchauffé for an almshouse, a theatre, or a church—though in the paucity of ideas the same Ionic portico, or Italian campanile are made to figure as the stock of all and sundry the compositions of some of our inspired artists.

Southampton Docks.—The Dock Company have, we understand, contracted for and commenced the construction of a second dry dock, to be completed in November next. Messrs. William Cubitt and Co. were the successful competitors, the amount of their tender being a little above £17,000, whilst that of Messrs. G. Baker and Son, the contractors for the new custom-house now so near completion, was we believe near £18,000. The dock is to be 250 feet in length upon the blocks, and hold two 500 ton ships at once, or one of all but the largest of the gigantic steam-ships so familiar to our waters, and one sailing ship of 500 tons burthen.

THE ROYAL ACADEMY EXHIBITION: ARCHITECTURE.

The competition for the Army and Navy Club-house, and the designs having to be sent in only a week before the receiving-days at the Academy, no doubt hindered some architects from preparing anything for the Exhibition;—not that there is this year any deficiency as to quantity, there being no falling off from the usual number of architectural subjects—and as usual, too, a good many of them might, as far as seeing them is concerned, just as well be away. There is, however, less variety than usual, or than used to be the case some seasons ago—since designs for churches greatly outnumber the subjects of any other class. One very uncommon circumstance is the extreme paucity of designs for domestic buildings of any kind—that kind excepted which consists of houses produced by wholesale, under the somewhat dubious title of "improvements." One design (No. 1077) shows us after what fashion the Castle Hill, at Dover, has just begun to be improved; and another (No. 1111). Dover Court new town, near Harwich—as to which last we cannot speak, not having noticed the drawing, wherefore it is perhaps luckier than the other. Churches alone excepted—and of them there is a full quota—there is very little to show us what has lately been done in architecture, or what buildings are either now in progress or about to be commenced. Even among the church subjects, too, we miss one that we should have been glad to meet with here; for the edifice is intended, we presume, to be superior in taste to most of the modern ones in the metropolis—to be a monument of its architect's skill as well as of its founders munificence. The church we allude to is the one which Mr. Ferrey is now erecting, in Westminster, for Miss Burdett Coutts. Therefore, supposing the design to be, as we have no reason to doubt, a worthy one, it would have been no more than a suitable compliment to that lady to have exhibited it. Like a good many others, however, Mr. Ferrey seems to have quite cut the Academy's exhibitions. There is a growing reserve on the part of those who either rank, or would be thought to rank, high in their profession, to contribute anything whatever to the Exhibition. This year there is not a single drawing by the Academy's own professor, or any of the other professors of architecture; and only a very few by members of the Institute. This is not exactly what ought to be, since it bespeaks indolence or apathy, if not contempt; and is, moreover, attended with one injurious consequence—namely, that the number of uninteresting and mediocre subjects can hardly fail to produce an unfavourable impression as to the actual state of the art among us.

It would be a monstrous untruth, were we to say we had some idea of being favoured by Mr. Blore with a peep at his design for the alterations at Buckingham Palace. That gentleman seems determined to carry on his operations with the utmost secresy, and to keep out of harms way—that is, out of the way of criticism—as long as he possibly can;—a species of mistrust that contrasts very strongly with the unquestioning confidence the public reposes in him. To nothing else than perfect confidence can we attribute that universal silence in respect to the Palace, which contrasts so very remarkably with the universal fuss made about a comparatively insignificant matter at the other end of Constitution-hill. We must, therefore, wait with patience till time reveals to us what neither Mr. Blore himself, nor any one of those who pretend to be in the secret—at least, to have seen "a sketch" of the design—chooses to let us know—namely, into what sort of a building the Palace will be metamorphosed. Architectural transformations seem to be just now the order of the day, for while Barry, who is now operating upon the Treasury Buildings, is, it seems, about to undertake the transformation of both the Horse Guards and Treasury, Mr. Sydney Smirke is not only enlarging the Carlton Club-house, but changing it into quite a different piece of architecture, as may be seen by the drawing of it at the Exhibition (No. 1109), which shows what the entire façade will be—and that the east front, if not the south one also, will be similar in design to the Pall-mall one. The change cannot fail to acquire for the Carlton considerable architectural rank and reputation, whereas the present club-house never had, notwithstanding its rank as such, any reputation at all as a building. The new structure will most assuredly add very greatly to the architectural character of Pall-mall; but it is not so certain that it will be altogether favourable to its neighbour, the "Reform"—it being, apparently, intended to eclipse the latter. At all events, the Carlton will present the larger façade of the two, and will be in a more florid style of Italian—in fact, a particularly florid one, the spandrel-spaces over the arches of the second order being entirely filled in with figures in relief—both a degree and a species of embellishment which we as yet possess no examples of in town. The upper or Ionic order is also a peculiar example in itself, at least as regards its entablature, whose frieze is unusually deep—so greatly exceeding the established proportions, that it would scandalise the sticklers for such matters, and bring down their censures upon Mr. Smirke, had he not sheltered himself under the authority and precedent of Sansovino, whom he has on this occasion chosen to follow pretty closely for the whole design of his exterior. Were it not for the drawing we have just been speaking of, there would be nothing in the Exhibition to show any building (besides churches) either erecting or or about to be erected in the metropolis,—if we except No. 1294, a very tiny model of the new Coal Market which is about to built in Lower Thames-street, at the corner of St. Mary-at-Hill. It will have two uniorm fronts, on two adjacent sides, with the corner rounded off in the two flower floors of the building, above which that portion will be carried up as a small insulated circular tower or campanile, that will be recessed within the re-entering angle, cut out there between the two fronts. This promises to be a novelty, but the model itself is such a mere toy as to size—as is, indeed, the case with all the models this year—that it is impossible to judge of more than the general shape of the structure. The idea of rounding off the corner of a building in such a manner as to render it an important—at any rate very ornamental—feature in the composition, is also displayed in No. 1284 (E. Christian), a design for the new Imperial Insurance Office, to which the second premium was awarded. There is also another design (No. 1198), by the same architect, for the same building; but we do not find here the design for it, which is to be executed; nor that for the Museum of Geology, in Piccadilly.

While unusual dearth prevails this season in regard to fresh subjects, representing actual buildings, there is the usual show of "old familiar faces"—familiar even to staleness—things that are known by heart: the Temple of Erectheus, the Arch of Titus, the Bridge of Sighs, the Temple Church, with sundry *et cæteras*, whose titles in the Catalogue spare us the trouble of looking at them. We might, perhaps, had we observed its title at the time, have looked at No. 1190, "Edinburgh from the South,"—if only to ascertain whether, as an architectural view, it was more satisfactory than No. 360, Roberts's large oil-picture of the Northern Metropolis, which has obtained from the critics a degree of laudatory admiration perfectly unaccountable to us—it being, in our opinion, neither good as a pictorial composition nor displaying any particular beauty of execution. On the contrary, it is heavy and opaque in colour. To our eyes, the architecture—for the most part very queerish in reality—looks very slovenly executed in this representation of it, and more like the work of a mere landscape painter than of one who has exercised his pencil chiefly upon subjects more or less strictly architectural. But we are playing the truant, so let us return to our own proper subject.

Next year we shall, in all probability, find here several of the designs for the Army and Navy Club-house; in the meanwhile, No. 1121 (W. A. and J. W. Papworth), has got the start of any of the others, that drawing being a coloured copy of the perspective view sent in by Messrs. P. to the competition. We cannot say that we at all approve of the design itself, any more than we do of the license taken in regard to scale, the Club-house being represented two or three feet higher than Winchester House, which innocent (?) species of untruth is contradicted by the proportions of the Pall-mall front—the latter being limited in width to sixty feet; consequently being, in that design, little if at all higher than it is wide—instead of being loftier, it would be about fifteen feet lower than Winchester House. Really, architects seem to be as little scrupulous about scales as they are about estimates. Theirs are not always the scales of justice, or of judgment either. Apropos of estimates—there was wonderful harmony in that respect among the competitors for the Club-house in question: even the estimate for one of the Gothic designs—which certainly looked as if it would cost double, or more than double, some of the others, it being studded all over with statues, canopies, and pinnacles—was only £30,000, although the two fronts and their ornaments were to be, not in papier maché, but in real Caen stone!

No. 1129, "Study for a Portal," appears to be a study for that in his design for the Club-house above-mentioned. It is not very favourably placed, being put over the door, where, though it is a rather large-sized drawing, it cannot be fairly seen—and yet seems well worth looking at, the general composition being very happy, and manifesting both originality and gusto. That subject, however, is not the only one that is disadvantageously placed, while many others, that are of comparatively little merit or interest, are perked just in our faces. Nos. 1199 and 1213, for instance, both of them two admirably executed interiors—the only ones of that class in the room—

are hung together, at right angles to each other, quite in a corner, and that an obscure one—so much, too, below the eye, that they cannot be inspected without stooping; and the one and the other is so full of elaborate detail, that if once assumed, the stooping posture is likely to be prolonged to weariness. No. 1199, "Design for the Decoration of the Old Billiard-room at Stapleford Hall," (J. Dwyer), would have been all the better, had the figures introduced in it been omitted—unless the artist had employed some one more *au fait* in figure-drawing than himself, to put them in: but in his own department he is admirable. The other subject, No. 1213, (L. W. Collman), which is simply styled "View of a Library," represents a room which has lately been decorated in a highly recherché manner by Mr. Collman himself, whose taste seems to be far more refined than that of Sang. This drawing has the advantage over the other in having no figures; though we would at any time readily tolerate poorly drawn figures, for the sake of similar subjects—which, being apartments in private residences, cannot be generally seen, or even known of, except they are portrayed by the pencil. Right glad, therefore, should we have been to see here a drawing of the Ball-room which Mr. Barry has just fitted up at St. John's Wood Lodge, for Sir Isaac Goldsmid, and which is reported to be a fine specimen of the Cinque-cento style. Of that style there is a specimen here, viz.: No. 1262, "Ceiling by Pietro Perugino, in the Sala di Combio at Perugia," (D. Wyatt),—an exquisite drawing, that requires to be looked at as closely as the illuminiated arabesque and borders of some precious manuscript—yet here hung where it is hardly observable. A somewhat similar fate attends No. 1233 (J. Thomas), a composition for a magnificent chimney-piece, forming, unlike those of these degenerate days, a stately mass of sculpture.

Churches—both old and new—form the great mass of architectural subjects; nor do they display much variety, or attempt at originality—for they all affect to adhere most literally to the mediæval character, and to mediæval ideas, as if the aim was to resist all further progress in art. At any rate, so many subjects, all of the same kind, gives a great sameness to this part of the Exhibition,—the appearance of much greater sameness than there perhaps really is; because, where so many drawings are so much alike in their general subject, one effaces the recollection of another;—with which remark we will bid adieu to our own subject, if not finally—as may prove the case—at all events for the present.

THE TUSCAN "MAREMME"—AND THEIR IMPROVEMENTS.

These, geologically speaking, recent abodes of, or upheavings from out, the ocean, have of late claimed much of public attention, and many interesting memoirs have been published thereon, in the Transactions of the Academia dei Georgiofili, and elsewhere. The most characteristic of the Maremme is the north-west part on the sea shore, where the river Cecina, descending from the hills of Volterra, reaches the Mediterranean. Those, as well as the Piombino Maremme, were once Sienese territory, and remained deserted and most unwholesome for centuries past. The lower Maremme were still more so—also for the reason, because there are no large swamps north of the lake of Piombino. Beyond that lake and the promontory of Populoniæ, the land assumes a less frightful character, and the awful devastation decreases gradually if we pass the Cecina. The tier of mountains, which south of Leghorn extends close to the sea (the Monte nero), encompasses the flat sea-shore lands, as by a semi-arc; and the river Cecina descends, bifurcate, into the sea; along the coast, water stagnates in numerous bogs, while the more depressed parts are filled with forests. The land of the Maremme belongs, mostly, to a small number of proprietors. It is here where the greatest improvements have taken place. Government having made the necessary arrangements with them, the land was divided into *saccate* (1 = 6,300 square mètres), the forest, or rather shrubbery, cut down, and the land put under cultivation. The worst part of the sea-shore was to be drained and dried by government itself. The dense forest, mostly covered with underwood, and completely in its primeval state, and which, on the slightly inclined terrain, had greatly contributed towards the *embogueing* of the land,—was cut down. The soil which thus was made to appear, proved to be mostly alluvial earth, resting on a stratum of grit, rich in fossil shells—and has already yielded the finest crops of wheat and maize. Drains of all sizes have completed the work of dessication.

Somewhat differently the long seam on the sea shore was to be treated—but here, an elevation of the terrain was to be effected, which was done by using the slime and silt of the Cecina; an expedient which has yielded triumphant results in the Valley of the Chiana and elsewhere.* On this seam, the forest has not only *not* been cut down, but even completed by systematic plantations, for opposing a barrier to the sweeping of the sea breeze. A number of vicinal ways have been opened—all to converge into the splendid Via Maremma, a line of road undertaken at the especial command of the Grand Duke of Tuscany. It traverses these swamps in their whole extent, and abuts at one side at Leghorn, and on the other extends to Florence and Siena—and the Roman road by the southern valleys of Tuscany. The air, most deleterious hitherto, has, on account of the many drains, dykes, and other hydraulic works, of the many fires and other domestic operations, improved most wonderfully, and will, no doubt, improve still more. The projected railway from Leghorn to Civita Vecchia will greatly increase the importance of these new lands.

The products of the Maremme, hitherto of little value for want of communication, consist of timber for construction, charcoal, potash, iron, sulphur, borax, alum, &c.; and the number of ships employed on the coast increases rapidly. The harbours of this coast, however, are in a deplorable condition, as there are none of any importance between Leghorn and Civita Vecchia. That of Piombino is full of sand and slime, but it would be possible to correct it. The embouchure of the swamp of Castiglione della Descaja, hitherto merely used for small coasting vessels, could, no doubt, be also improved. The southern part of the Maremme has three small harbours—Talamone, famous in antiquity, now blocked up with sand and slime, with the pestiferous air resulting therefrom, and Port Ercole. More important is Port St. Stefano, founded by fishermen on account of its healthy situation, which, by the aid of a few judicious constructions, could become very important. The improving of these sea-outlets would much increase the industrial resources of the Maremme, whose mineral riches may be shortly adverted to. The iron stands in the first rank, but the making of borax in the hills of Volterra is also of great importance. Timber of all kinds also abounds, as the forests of the crown alone extend over 10,000 hectares. The clearing of the terrain began here at the end of the last century—first, with the nearer hills, then the slopes of the Appennines. The destruction of these forests was soon followed by great calamities, here and elsewhere. In that of Pratovechio, government has made, of late, great improvements, and during five years, 1,200 hectares have been planted with different sorts of pines. Being placed at a distance of three yards from each other, 3,600,000 trees have been planted, which, in 40 years, will yield 15,000,000 trees fit for construction.

A few observations on the geological character of the Maremme may best conclude this paper. It cannot be doubted, that it was the alluvium poured forth from the rivers, which has filled up the gulph which once occupied this place. This, however, was again modified by the *reaction* of the sea, which formed on the alluvium various dykes and elevations, and thus shaped the whole surface of the land. V. Fossombroni, an author of note, says that this took place in the first centuries of the Christian era—to prove which, he cites the Peutinger tables, &c. Against this, M. Salvagnoti asserts, that along the whole sea shore, in parts quite close to it, there is a dyke of sea sand (at times one mile broad), on which the remains of a Roman road have been found, which is the Via Aurelia, built 100 years B.C.; that parts of it, going in the direction of Rome, have been used for making the new road, &c., in 1826. These latter are forcible facts, and prove—that the formation of the Maremme, albeit recent, still precedes the Christian era. Hence it follows, that the alluvium of the rivers formed that land, and that for draining the swamps, which are the remnants of old gulphs of the sea, the means hitherto employed have been the right ones.

We need scarcely state, that the above remarks will be useful not only in reference to the bog lands of Ireland and Scotland, but still more to many of our distant colonies.

J. L——y.

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* The geological neutralization, if we may say so, of extensive sand lands with the adjacent bogs and swamps, as is the case in the Mont Brandedburg, as well as near Sidney, New South Wales, has been hitherto quite overlooked. By placing two substances, quite unproductive by themselves, in such close juxta-position, nature seems to have urged men to make them reciprocally available.

There has been a great contest this month about the ventilation of the House of Lords, Dr. Faraday having lectured at the Royal Institution in praise of Mr. Barry's plan, and Dr. Reid having lectured in answer at Willis's Rooms, and in defence of himself.

ON THE INDUCTION OF ATMOSPHERIC ELECTRICITY ON THE WIRES OF THE ELECTRIC TELEGRAPH.

By PROFESSOR JOSEPH HENRY.

The action of the electricity of the atmosphere on the wires of the electrical telegraph is at the present time a subject of much importance, both on account of its practical bearing, and the number of purely scientific questions which it involves. I have, accordingly given due attention to the letter referred to me, and have succeeded in collecting a number of facts in reference to the action in question. Some of these are from the observations of different persons along the principal lines, and others from my own investigations during a thunder-storm on the 19th of June, when I was so fortunate as to be present in the office of the telegraph in Philadelphia, while a series of very interesting electrical phenomena was exhibited. In connexion with the facts derived from these sources, I must ask the indulgence of the Society in frequently referring, in the course of this communication, to the results of my previous investigations in dynamic electricity, accounts of which are to be found in the Proceedings and Transactions of this Institution.*

From all the information on the subject of the action of the electricity of the atmosphere on the wires of the telegraph, it is evident that effects are produced in several different ways.

1. The wires of the telegraph are liable to be struck by a direct discharge of lightning from the clouds, and several cases of this kind have been noticed during the present season. About the 20th of May the lightning struck the elevated part of the wire, which is supported on a high mast at the place where the telegraph crosses the Hackensack River. The fluid passed along the wire each way, from the point which received the discharge, for several miles, striking off at irregular intervals down the supporting poles. At each place where the discharge to a pole took place, a number of sharp explosions were heard in succession, resembling the rapid reports of several rifles. During another storm, the wire was struck in two places in Pennsylvania, on the route between Philadelphia and New York; at one of these places twelve poles were struck, and at the other eight. In the latter case the remarkable fact was observed, that every other pole escaped the discharge; and the same phenomenon was observed, though in a less marked degree, near the Hackensack River. In some instances the lightning has been seen coursing along the wire in a stream of light; and in another case it is described as exploding from the wire at certain points, though there were no bodies in the vicinity to attract it from the conductor.

In discussing these and other facts to be mentioned hereafter, we shall, for convenience, adopt the principles and language of the theory which refers the phenomena of electricity to the action of a fluid, of which the particles repel each other, and are attracted by the particles of other matter. Although it cannot be affirmed that this theory is an actual representation of the cause of the phenomena as they are produced in nature, yet it may be asserted that it is, in the present state of science, an accurate mode of expressing the laws of electrical action, so far as they have been made out; and that though there are a number of phenomena which have not as yet been referred to this theory, there are none which are proved to be directly at variance with it.

That the wires of the telegraph should be frequently struck by a direct discharge of lightning, is not surprising, when we consider the great length of the conductor, and consequently the many points along the surface of the earth through which it must pass peculiarly liable to receive the discharge from the heavens. Also, from the great length of the conductor, the more readily must the repulsive action of the free electricity of the cloud drive the natural electricity of the conductor to the further end of the line, thus rendering more intense the negative condition of the nearer part of the wire, and consequently increasing the attraction of the metal for the free electricity of the cloud. It is not however probable that the attraction, whatever may be its intensity, of so small a quantity of matter as that of the wire of the telegraph, can of itself produce an electrical discharge from the heavens; although, if the discharge were started by some other cause, such as the attraction of a large mass of conducting matter in the vicinity, the attraction of the wire might be sufficient to change the direction of the descending bolt, and draw it in part or whole to itself. It should also be recollected that, on account of the perfect conduction, a discharge on any part of the wire must affect every other part of the connected line, although it may be hundreds of miles in length.

That the wire should give off a discharge to a number of poles in succession, is a fact I should have expected, from my previous researches on the lateral discharge of a conductor transmitting a current of free electricity. In a paper on this subject, presented to the British Association in 1837, I showed that when electricity strikes a conductor explosively, it tends to give off sparks to all bodies in the vicinity, however intimately the conductor may be connected with the earth. In an experiment in which sparks from a small machine were thrown on the upper part of a lightning-rod, erected in accordance with the formula given by the French Institute, corresponding sparks could be drawn from every part of the rod, even from that near the ground. In a communication since made to this Society, I have succeeded in referring this phenomenon to the fact, that during the transmission of a quantity of electricity along a rod, the surface of the conductor is charged in succession, as it were, by a wave of the fluid, which, when it arrives opposite a given point, tends to give off a spark to a neighbouring body, for the same reason that the charged conductor of the machine gives off a spark under the same circumstances.

It might at first be supposed that the redundant electricity of the conductor would exhaust itself in giving off the first spark, and that a second discharge could not take place; but it should be observed, that the wave of free electricity, in its passage, is constantly attracted to the wire by the portion of the uncharged conductor which immediately precedes its position at any time; and hence but a part of the whole redundant electricity is given off at one place; the velocity of transmission of the wave as it passes the neighbouring body, and its attraction for the wire, preventing a full discharge at any one place. The intensity of the successive explosions is explained by referring to the fact, that the discharge from the clouds does not generally consist of a single wave of electricity, but of a number of discharges along the same path in rapid succession, or of a continuous discharge which has an appreciable duration; and hence the wire of the telegraph is capable of transmitting an immense quantity of the fluid thus distributed over a great length of the conductor.

The remarkable facts of the explosions of the electricity into the air, and of the poles being struck in interrupted succession, find a plausible explanation in another electrical principle which I have established, namely, in all cases of the disturbance of the equilibrium of the electrical plenum, which we must suppose to exist throughout all terrestrial space, the state of rest is attained by a series of diminishing oscillations. Thus in the discharge of a Leyden jar, I have shown that the phenomena exhibited cannot be explained by merely supposing the transfer of a quantity of fluid from the inner to the outer side of the jar; but in addition to this we are obliged to admit the existence of several waves, backwards and forwards, until the equilibrium is attained. In the case of the discharge from the cloud, a wave of the natural electricity of the metal is repelled each way from the point on which the discharge falls, to either end of the wire, is then reflected, and in its reverse passage meets in succession the several waves which make up the discharge from the cloud. These waves will therefore interfere at certain points along the wire, producing, for a moment waves of double magnitude, and will thus enhance the tendency of the fluid at these points to fly from the conductor. I do not say that the effects observed were actually produced in this way; I merely wish to convey the idea that known principles of electrical action might, under certain circumstances, lead us to anticipate such results.

2. The state of the wire may be disturbed by the conduction of a current of electricity from one portion of space to another, without the presence of a thunder-cloud; and this will happen in case of a long line, when the electrical condition of the atmosphere which surrounds the wire at one place is different from that at another. Now it is well known that a mere difference in elevation is attended with a change in the electrical state of the atmosphere. A conductor, elevated by means of a kite, gives sparks of positive electricity in a perfectly clear day; hence if the line of the telegraph passes over an elevated mountain ridge, there will be continually, during clear weather, a current from the more elevated to the lower points of the conductor.

A current may also be produced in a long level line, by the precipitation of vapour in the form of fog at one end, while the air remains clear at the other; or by the existence of a storm of rain or snow at any point along the line, while the other parts of the wire are not subjected to the same influence.

Currents of sufficient power to set in motion the marking machine of the telegraph have been observed, which must have been produced by some of these causes. In one case the machine spontaneously began to operate without the aid of the battery, while a

* American Philosophical Society, 1846.

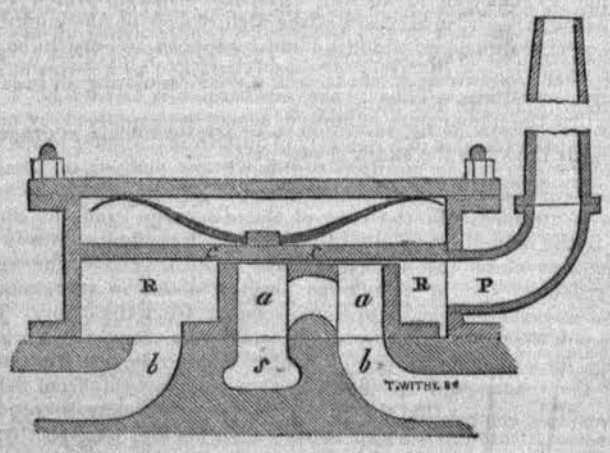
snow-storm was falling at one end of the line, and clear weather existed at the other. On another occasion a continued stream of electricity was observed to pass between two points at a break in the wire, presenting the appearance of a gas-light almost extinguished. A constant effect of this kind indicates a constant accession of electricity at one part of the wire, and a constant discharge at the other.

3. The natural electricity of the wire of the telegraph is liable to be disturbed by the ordinary electrical induction of a distant cloud. Suppose a thunder-cloud, driven by the wind in such a direction as to cross one end of the line of the telegraph at the elevation, say of a mile; during the whole time of the approach of the cloud to the point of its path directly above the wire, the repulsion of the redundant electricity with which it is charged would constantly drive more and more of the natural electricity of the wire to the further end of the line, and would thus give rise to a current. When the cloud arrived at the point nearest to the wire, the current would cease for a moment; and as the repulsion gradually diminished by the receding of the cloud, the natural electricity of the wire would gradually return to its normal state, giving rise to a current in an opposite direction. If the cloud were driven by the wind parallel to the line of the telegraph, a current would be produced towards each end of the wire, and these would constantly vary in intensity with the different positions of the cloud. Although currents produced in this way may be too feeble to set in motion the marking apparatus, yet they may have sufficient power to influence the action of the current of the battery so as to interfere with the perfect operation of the machine.

(To be continued.)

LOCOMOTIVE SLIDE VALVES.

SIR—The following is a scheme for relieving the slide valves of a locomotive engine from the great pressure which is upon them (in the ordinary valves). It is thus:



In this sectional view, the slide will be seen to have two ports a, a' connected with each other, and of equal area to those on the cylinder face, b, b'; c is a plate placed on the back of the valve, and kept there by means of a strong spring, which should be tested, to stand the amount of pressure there would be on a space equal to the area of the two ports a, a'; s is a steam-way, through which the steam is admitted, passing from thence through the ports into the cylinder. The pressure on the space between the ports is neutralised by the strip e, to which I think there can be no objection, as it would only open and shut the steam-way simultaneously with the steam ports in the cylinder; therefore, the supply of steam would be as regular as were it full-open during the entire travel of the valve. The exhaust is formed through the chamber R, and the blast-pipe P. The lap of the valve is of course at the will of the engineer. Hoping that the scheme will meet with your approbation and insertion in your next,

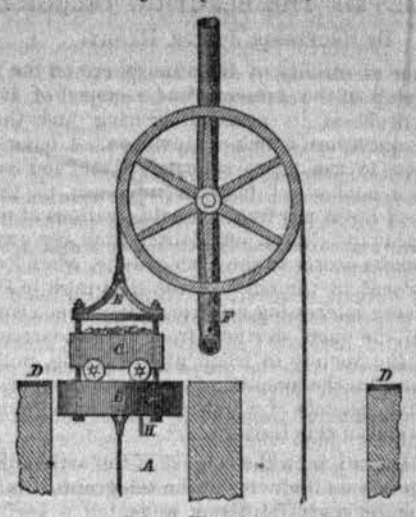
I am, Sir, your's, very respectively,

F. A. BUCKNALL.

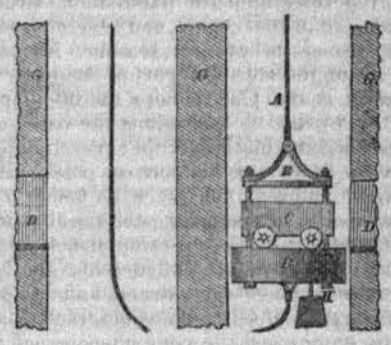
Bristol, May 22, 1847.

WATER-BALANCE WINDING MACHINE.

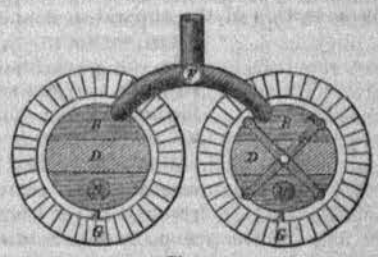
We are indebted for the following description and engravings to the Mining Journal.



Elevation.



Description.—A A A A, the pits; B B B B, plate-iron water-tanks; C C, two wagons; D D D D D D, part of the rails, and the bridge across the top of the tanks; E E E, different views of the cross connecting the tanks and wire ropes; F F, water-pipes, provided with valves, for filling the tanks—to be opened and shut by levers, under the command of the attendant; G G G G G, the walling, or steaning,



Plan.

of the pits; H H, exit valves, at the bottom of the tanks. The large wheel has a groove to receive the rope, or chain, as the case may be, and furnished with a brake, to regulate the motion and gripe tight, as the wagons reach the proper places for pushing off and on. It will be necessary to attach a rope (or chain) to the bottom of the tanks, similar to that annexed, in order to keep up the equilibrium through the whole depth of the pit; for, where the ground is favourable, one elliptical pit will be a saving in sinking and steaning, as well as in the size of the wheel, which may be proportionably less.—The upright pipe, seen behind the wheel, may be surmounted by a cistern, to relieve the pipes and joints from the shock occasioned by suddenly checking the momentum of the water-current along the horizontal pipes.

It should be understood, that guide-rods, though not shown, are necessary to keep the tanks steady.

It is now 20 years since I erected one of these machines, which has been in constant work ever since, and is still raising 500 tons, from a depth of 50 yards, in 12 hours.

Coleford, May 8.

JOHN WALKINSHAW,

REGISTER OF NEW PATENTS.

PRESERVATION OF ORGANIC SUBSTANCES.

JOHN RYAN, of the Royal Polytechnic Institution, doctor of medicine, and professor of chemistry, for "*Improvements in the preservation of organic and other substances.*"—Granted Oct. 17, 1846; Enrolled April 17, 1847.

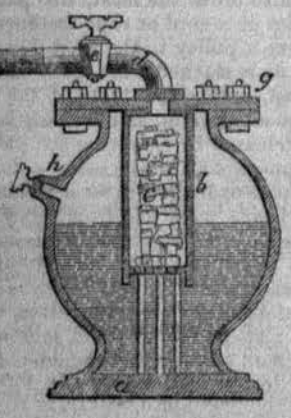
These improvements relate, firstly, to preserving organic and other substances, by supplying thereto a mixture of gases and vapours which are opposed to combustion and decomposition, applied either in combination with air or instead of air. The gases preferred are either a mixture of carbonic and chloro-hydric acids, or a mixture of carbonic and acetic, or pyroligneous acids.

For preserving animal matters, a mixture of carbonic and pyroligneous acids in a gaseous form, is preferred, because of the presence of a small quantity of kreasote; sometimes a little kreasote is added and allowed to pass over with the gases into the vessel containing the substance to be preserved. These gases are obtained from any suitable carbonates, but carbonate of lime in the form of marble is preferred, to which is sometimes added common chloro-hydric acid, diluted with half its bulk of water; by which a mixture of carbonic and chloro-hydric acid gases is procured. If it be necessary to render the mode of preservation more complete, there is added a small quantity of kreasote, in the proportion of half-a-drachm to two quarts of the liquid. In this case, the mixed acids carry off with them a portion of the kreasote vapour. In other cases, to obtain the carbonic acid of the marble, rough or unpurified pyroligneous acid, containing small quantities of kreasote, is used; by which a mixure of carbonic pyroligneous acid and the vapour of kreasote is obtained. If coarse pyroligneous acid cannot be obtained, either acetic acid and a small quantity of kreasote, in the proportions of half-a-drachm to two quarts of the acid, or common vinegar with the same quantity of kreasote, may be used. When organic matters, such as meat, are to be preserved, they are to be deposited in suitable air-tight boxes.

For preserving vegetable substances, or fermented liquids, the vapour of kreasote is not to be used, but carbonic acid alone, obtained by the action of the chloro-hydric, or other suitable acid containing no kreasote.

For preserving fermented liquids, it is necessary to wash the carbonic acid by passing it through a small vessel containing clean water, to remove any of the chloro-hydric or acetic acids.

The second part of the improvements relates to the constructing a self-acting apparatus for generating the gases, and its application to supplying the vessel containing the articles to be preserved. The annexed figure is a section of the apparatus, which may be made of glass, earthenware, iron glazed inside, or pure lead, of a sufficient strength. *a* is a vessel or chamber for holding the acid, and *b* an internal chamber, with a perforated false bottom, for holding broken pieces of marble; *c* is a capping, secured by screw bolts; *d* a bent tube with stop-cock, to which is attached a flexible tube *e*, communicating with an air-tight box or safe, containing the articles to be preserved; *f* is an aperture furnished with a plug, for filling the vessel with acid when required; to fill the interior vessel, it is necessary to remove the capping.



The action of the apparatus is as follows:—when the door of the box or safe containing the article to be preserved is open, the pressure of the air on the acid in the outer chamber *a*, causes the acid to rise among the broken marble in the chamber *b*, when gas is generated and is carried off by the tube *d*, to the preserving box or safe; when the door of the latter safe is closed air-tight, the vessel is filled with the gases, mixed with air, and when fully charged, the pressure of the gas on the acid in the inner vessel, *b*, will force the acid out into the outer chamber *a*, leaving the marble dry; consequently, the action of generating the gases will cease until the door of the preserving box is opened again.

SHIPS AND PROPELLERS.

JOHN BUCHANAN, of Queen-square, Westminster, gentleman, for "*Improvements in ships or vessels, and in the propelling thereof, and in securing the same from floatal damage, certain parts of which machinery may be used for motion on land.*" Granted August 15, 1846; Enrolled February 4, 1847.

THE improvement consists, first, in the formation or construction of ships or vessels, by means of lines, as hereinafter described; and, secondly, to the application of a blade or blades for the propelling of ships or vessels, so constructed as to yield to the adverse pressure of the water when required.

The patentee states that the object of the first part of his invention is to enable the lines of a ship or vessel to be drafted so that all the lines will correctly run into each other, and that they will not require adjustment by shifting the transverse sections. The work is done according to true geometrical bases throughout, beginning with the main frame, and in lieu of water lines, ribband lines, and buttock lines, with their necessary accompanying balance and adjusting frames, the patentee only makes use of the midship section, an upper extreme height-of-breadth-line, and one main diagonal on each side of the hull, uniting or fitting in all the transverse sections from the upper height of breadth to the main diagonal, and thence down to the keel, in the same manner as if followed in constructing the main frame, viz., bisecting, or halving the angles contained within the several perpendiculars, (or straight lines approaching more or less to the perpendicular,) and also all the angles within the straight lines crossing these perpendiculars and the diagonals at the points where the transverse sections respectively cross the main diagonals. Lines traced through these bisections of the angles form the outside of the frame of the ship. The longitudinal curves being formed nearly in the same manner, viz., halving the angles contained within the perpendiculars or lines bounding the ends of the oblong figures and sides or bottom of the said figures, whether vertical, horizontal, or diagonal, and lines connecting the extreme points or base lines of these triangles, such being a pure trigonometrical and geometrical formula for determining the transverse and longitudinal lines of a ship or vessel, according to this invention, regulating her form from the straight lines of the stem, stern post, and keel, to the greatest extent of breadth and depth, beautifully proportioning all her lines, and each line relatively partaking of each other's qualities upon the principle of the two sides and base of a cone regulating all the lesser diameters thereof in due proportion.

The second part of the invention is for improvements in propelling vessels, as shown in the annexed engraving:—

Fig. 1.

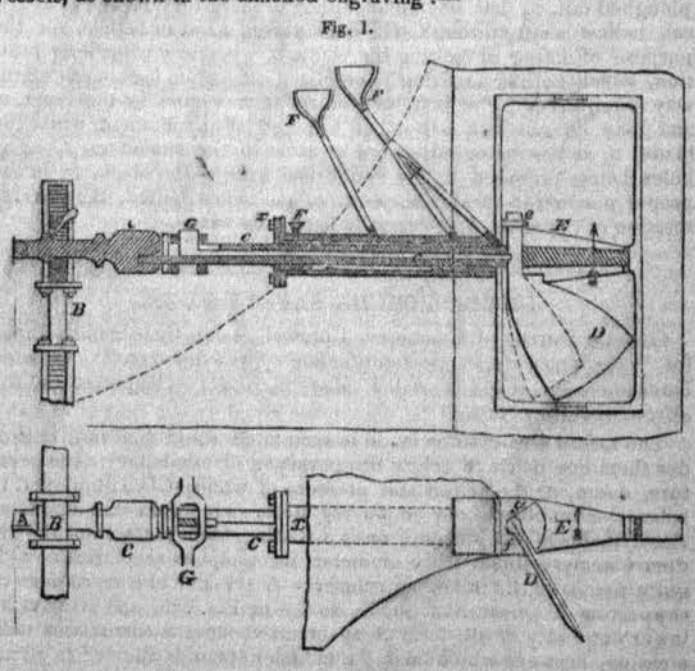


Fig. 2.

Fig. 1 is a section showing the internal construction, and a plan (as it would appear from beneath) of the stern end of a vessel, to which one modification of this part of the invention is applied.

A, represents the revolving shaft driven by the steam-engine, or other power. The bearings are supported on elastic springs, B, so that any bending of the vessel does not bind the journals of such shaft, which are allowed to arrange themselves in a line by the com-

pensating elasticity of such springs. The shaft, A, is connected or coupled at *c*, to the shaft, C, which carries the propelling-blade, D, formed as a cylindrical axis, which passes through the shaft, C, and the boss, E, where it is held by means of the cotter, *e*. The cotter is cut or split in a different direction to that generally practised. This form of cotter is fixed by opening the slit by a drift or wedge, and, while open, rivetting in the small bolt, which leaves the cotter perfectly secure and safe. The blade, D, thus supported on the shaft, C, partakes of the revolution of such shaft at the same time that it is free and at liberty to move on its own axis; so that, supposing the shaft, C, to revolve in the direction indicated by the arrows, the resistance of the water will place the blade, D, in the position represented, resting against the shoulder or face, *f*, formed in the boss, E, as seen at fig. 2; but when the revolution of the shaft, C, is reversed, the blade will vibrate on its axis from the same resistance of the water, and assume the opposite position, resting on the shoulder or face, *g*. The angles formed by the shoulders, *f* and *g*, with the shaft, C, are slightly varied, so that the angle formed by the shoulder, *g*, being more acute, will drive quicker when required, without any increase of speed in the rotation of the shaft, C. By this arrangement the blade, D, having free play on its axis between the shoulders, *f* and *g*, will at all times yield to any adverse pressure which may arise from the superior velocity of the vessel to that generated by the propulsion of the blade, D, itself; so that, supposing sail to be on the vessel at the same time that the propeller is in action, and that the gale should suddenly carry the vessel beyond the speed due to the propeller, it will instantly yield to the adverse pressure, and present no resistance to the course of the vessel. And in like manner, when the vessel is under sail, and no rotation is imparted to the shaft, C, the blade, D, will yield to the adverse pressure of the water, and assume that position which prevents the least resistance to the onward course of the vessel. The shaft, C, is supported in a hollow tube, *x*, *x*, passing through, and firmly fixed in, the dead wood of the vessel's stern, and lubricated at various points by means of pipes, marked F, carried to such an elevation as to support a column of oil sufficient to overcome the pressure of the external water, and ensure the necessary supply of oil where required, which is not always the case in the ordinary arrangements of machinery of this nature. It will be also seen, in this figure, that the force or pressure imparted from the rotation of the blade, D, to the vessel, is received from the boss, E, resting and revolving against the fixed tube, *x*, *x*, which carries the shaft, C, at a point immersed in the external water, which prevents it heating whilst the superior column of oil, supplied by the small tube, F, lubricates the parts in contact. The shaft, C, is formed of two semi-cylindrical halves, the centre or flat surface of each being planed or ploughed out, so that when placed face to face, they form a cylindrical, hollow shaft, through which is passed a rod or bolt, *o*, for the purpose of fixing or bolting the blade, D, when in a propelling position, which bolting or fixing is practised only when backing or sternway is required. The bolt, or rod, *o*, is traversed by the lever, G, and may be put into action, or relieved at any moment, while the blade, D, is resting on either one or other of the shoulders, *f*, or *g*, holes being provided in the cylindrical axis of the blade, D, in the proper position to receive the bolt, *o*, and when bolted, the reverse rotation of the shaft, G, necessarily backs the vessel.

GUTTA PERCHA SAFETY FUZE.

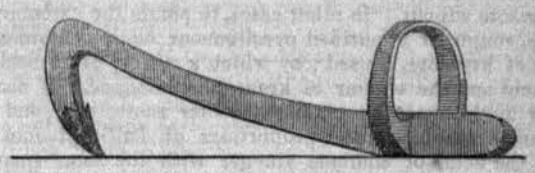
GEORGE SMITH, of Camborne, Cornwall, safety-fuze manufacturer, for "*Improvements in the manufacture of safety-fuzes.*" Granted November 12, 1846; Enrolled May 8, 1847. (Reported in the *Mechanics' Magazine.*)

The safety fuze is to be made in such manner and material, to render them less liable to injury from changes of atmospheric temperature, damp, or the action and pressure of water, when employed in submarine operations, by employing gutta percha to enclose an interior cylinder of gunpowder; or as a coating, or covering, for the ordinary hempen fuzes. The cylinder for gunpowder is made with gutta percha in the following manner:—A cylinder of iron, capable of supporting a pressure of 500 lb. to the square inch, and made at its lower extremity of the form of an inverted cone, is surrounded with a casing, between which and the cylinder steam is allowed to circulate. The lower part of the cylinder—that is, the apex of the inverted cone—terminates in a pipe, which is carried down through a cistern of cold water. A gunpowder chamber, or funnel, is supported by suitable bearings in the centre of the cylinder, and, passing through the inverted cone, terminates in the pipe below the joint. The funnel is filled with gunpowder, having a thread through the centre thereof, to facilitate its passage; and the cylinder with gutta percha. The steam is made to circulate between the cylinder and outside casing, until the gutta percha assumes the consistency of putty. It is then pressed through the pipe, and, passing round the gunpowder funnel, takes the form of a hollow tube, while it becomes filled with gunpowder. The fuze, in passing through the cold water cistern, acquires a degree of firmness, which may be increased by causing it to pass between two rollers, grooved on their peripheries, and made to revolve in opposite directions. The ordinary hempen fuzes are also coated with gutta percha in the following manner:—An iron cylinder, similar to the preceding, and heated in like manner, is filled with gutta percha, which is subjected to the pressure of about 300 lb. to the square inch. The sides of the cylinders are bored with holes of different diameters, to suit the size of different fuzes, to which inlet and corresponding outlet pipes are attached. When the gutta percha is sufficiently softened, a wire, hooked at the end, is made to enter one of the inlet pipes, and, passing through the mass of gutta percha, to come out at the exit one opposite. The fuze is cooled in its passage through the exit pipe by an arrangement similar to the one described.

SHIPS' ANCHORS AND MASTS.

JOHN JAMES ALEXANDER MACCARTHY, of Sidney Terrace, Brompton, gentleman, for "*Improvements in anchors, and fids for masts for vessels.*" Granted Oct. 22nd, 1846; Enrolled April 22nd, 1847.

THE improvements relate, firstly, to an improved form of anchor for ships, as shown in the annexed engraving. It is made with only one fluke, and a stem or shank of the form shown in the engraving,



in order that the centre of gravity of the mass shall be as near as possible to a line drawn from the point of the fluke to that part of the shank where the stock is attached. The stock is of a heart shape, made of iron, welded to the shank, or it may be formed separately, and secured by any suitable means. This stock is constructed with the greatest proportion of metal nearest the shank, to render it stronger, and more capable of resisting the shocks and strains it may be subjected to, and, at the same time, it keeps the greater proportion of the weight near the desired point. If an anchor be constructed as described, whichever way it may fall, it will, by its own gravity, take the position shown in the engraving.

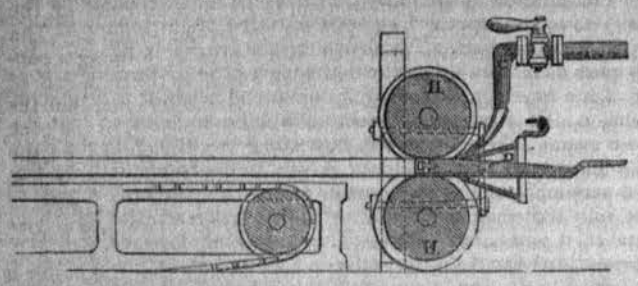
The second part of the improvements consists in introducing a ratchet and pall for supporting the top-masts of vessels; the ratchet, being secured to the top-mast, and the pall hinged to the lower mast, the mast is raised and lowered in the usual way by a pulley let into the lower end thereof, the mast as usual passing through holes in the cap and cross-tree; when it is desired to lower the mast, the pall is withdrawn from the ratchet, by means of a cord or rope fastened to the back of the pall, and passes over a pulley in the mast down to the deck. In raising the mast, the rope is slacked; the pall, falling by its own gravity against the top-mast, enters the teeth of the ratchet on the mast's attaining the requisite height, and securely holds it in the required position till again released by removing the pall as before described. Another improvement consists in using a hoop, supported from the cross-tree by staples or hinges, in such a manner that it may be drawn towards the lower mast and from under the upper mast by a chain, the same being lowered by the pulley as usual. When the mast is raised, the chain is slacked, and the hoop or fid falling by its own gravity in a perpendicular position, receives the weight of the mast, and in order to retain it in a proper position, that part of the end of the mast which rests on the fid is cut somewhat shorter, the fid being drawn by the chain against the shoulder thus formed, and retains it securely in the desired position.

IRON TUBING.

JAMES ROOSE, of Darlaston, in the county of Stafford, tube manufacturer, for "*Certain improvements in welded iron tubing.*" Granted August 29, 1846; Enrolled February 27, 1847.

The improvements consist, first, in taking a strip of iron of a required length, breadth, and thickness, according to the size of tube, and bevilling or chamfering the two edges of the lap joint, as is well understood amongst tube manufacturers; then turning the two sides

of one end of the skelp or strip when at a red heat, the two edges curling towards each other, and one lapping under the other, so that the first end is made smaller than the size of the tube when finished; the skelp, or partly turned and partly flat strip, is then put into the furnace, and when brought up to a welding state, it is introduced into



a bell or mouth-piece, D, similar to that shown in the engraving, and the turned-up end is sufficiently inserted through the bell and between the rolls, H, H, to allow the plyers on the drawbench to catch hold of the end of the skelp; the chain being then set in motion, the skelp will draw through the bell, and, owing to the ridge on the bell, the one end of the skelp will be caused to overlap the other edge, and when it has left the bell, and it is in the pinch of the rolls, the place of contact of the rolls being the point which gives the welding pressure, the mandril being within and offering resistance to the internal part of the tube. Between the back part or small end of the bell, and the entrance of the rollers, there is a tube, *c*, through which is conveyed either hot or cold blast, blown by the engine; the end of this tube is fixed over the seam of the skelp or tube. The blast will have the effect of producing the metal at the seam or joint into a partly liquid state, or state of fusion. The rolls revolve by machinery, and traverse at the same surface speed as the chain on the drawbench, so that the draft on the tube is eased, and the draft has not the tendency to stretch the tube more in one place than another, nor to pull the tube in two. The mandril is placed in front of the bell, the bulb protruding through and into the groove of the rolls. By this process, the skelp, with the one end turned up, is produced at one heat, and at one operation, into a lap-joint welded iron tube. This process will be found most advantageous in the production, particularly of lap-joint iron tubes, on account of the small quantity of hands required, the very great facility it offers in their production, and the superiority of the article produced. They will be found to stand a greater pressure on the inch, according to the substance of metal, than other similar tubes produced by any of the other known processes, on account of the properties of the iron being retained, the tube only having been heated once. By other processes the tubes are repeatedly heated in the furnace, which tends to destroy the fibres of the iron. Another very great advantage resulting from this process, is in the blast playing on the seam or joint of the tube before it goes under the welding pressure, so that in all cases dependence may be placed on the joint being in a good welding state, which joint might in some degree have got chilled in the bell or mouth-piece, in the bending.

SHEATHING FOR SHIPS.

GEORGE FREDERICK MUNTZ, Esq., M.P., of Ley Hall, near Birmingham, for "*An improved manufacture of metal plates for sheathing the bottoms of ships or other vessels.*" Granted October 15, 1846; Enrolled April 15, 1847.

THIS invention relates to an improved manufacture of the sheathing metal of copper and zinc, described in the specification of a patent granted to the present patentee October 22, 1832, containing 60 parts copper and 40 parts zinc. The present improvements consist of an alloy of 56 parts of copper, 40¾ zinc, and 3¼ lead; in making the alloy, an additional quantity of zinc is used, on account of the loss of that material during the operation, so as to obtain an alloy containing the different metals in the above proportions. The lead acts an important part in the alloy, as, without it, the alloy would not oxidize sufficiently to keep the ship's bottom clean. The alloy, after being cast into ingots, is rolled into sheets (by preference, at a red heat), and then annealed; and, if desired, the sheets may be cleaned with a mixture of sulphuric and nitrid acids, properly diluted.

The patentee does not confine himself strictly to the above proportions, for the quantity of copper may be increased (which will, however, increase the cost of the sheathing metal), or it may be decreased to a slight extent; but it must not be reduced to fifty per cent. of the alloy produced. Although lead is mentioned in the above description, any other suitable metal may be used in place of it, but not with equal advantage.

The patentee claims the manufacture of sheathing metal, by so using other suitable metal or metals, when copper and zinc are combined for the purpose of sheathing, as to allow the mixture to contain a less proportion of copper than about sixty parts of copper and forty parts of zinc, and at the same time attain a sufficient degree of oxidation, and prevent separate action on the zinc.

IRON WIRE.

WILLIAM REID, of St. Pancras, Middlesex, engineer, for "*Improvements in the manufacture of wire.*"—Granted October 29, 1846; Enrolled April 29, 1847.—(Reported in the *Patent Journal.*)

This invention relates specially to the manufacture of iron wire, and also to the cleansing, or preparing the surface of the same, to receive a metallic coating, for the purpose of preventing oxidation, and has for its object the producing wires of greater lengths, and more perfect throughout its entire length, than can be effected by any means at present in use, and consequently better calculated for the purposes to which it is applied; more especially for transmitting the currents in electric telegraphs. For, whereas the bundles of wire, which average about 192 feet in length, and weigh 14 lb., are welded together when reduced to the size which they are intended to remain, the parts joined almost invariably being thicker than the rest, and at the same time rendered more brittle, and not unfrequently unsound. Now, the improvement in the first part of this invention, consists in welding end to end, scarf-wise, two, three, four, or more bars of iron, suitable for the purpose, and afterwards drawing them through the drawing machine, which process not only renders it the same size throughout, but by the strain required, effectually tries the different joints, which, if not sound, will give way, thus detecting any imperfections that arise in the construction. By this means, the patentee states he can readily furnish bundles of wire, of ten times the usual length, or even any length that may be required. After drawing, the wire is submitted to the annealing oven, which renders it as near as may be of a homogeneous quality throughout. With regard to the welding and drawing the iron, he does not lay any claim to the different operations when considered without respect to the order in which they are performed. Although these improvements have been specially mentioned as desirable for the manufacture of iron wire, it may also be equally well applied to the manufacture of steel wire. The second part of these improvements relates to the preparing wire to receive a coating of zinc or tin, in order to prevent it oxydizing; the ordinary method being to immerse it in a solution of nitric or sulphuric acid, from the unequal action of which, or one part remaining longer in the solution than another, the quality of the iron is much deteriorated. Now, according to this invention, the surface of the wire is prepared solely by a mechanical agency, or at least so far as to require only the acid very much diluted, the apparatus for which is as follows:—the coils, as they are taken from the annealing oven, are placed on reels, which revolve freely on vertical spindles, from a suitable frame-work. The form of these reels is the frustum of a cone, the small end being uppermost, so as to admit of the coil of wire being easily placed thereon; the ends of these coils, which may be five, six, or any convenient number, are led round, or rather half round three rollers, whose axes are also vertical; the sinuous route passes throughout, bending the wire alternately in contrary directions, as it turns over each roller; it is then conducted through another series of five rollers, whose axes lay horizontally; the wire, in passing the sinuous course prescribed by them, is bent in a contrary direction to that in passing the previous set of rollers. In order that one wire shall not ride on the other in its passage through the different sets of rollers, the wires are passed through suitable guides, and for the purpose of changing the point of contact on each roller, so that it shall not wear the same into grooves, the first series of rollers is caused to traverse backwards and forwards, in a direction at right angles to the motion of the wire; thus far the process is merely for breaking up any scale or oxide on the surface of the wire; it is then passed between two pieces of wood, faced with leather, or other substance, on which a constant stream of emery is permitted to flow from a hopper above; these pieces of wood are squeezed together with sufficient pressure to clean the surface of the wire, as it passes between them. Instead of leather, he sometimes applies grooved surfaces, cut in the manner of a file, suitable to receive the size of the wire to be cleaned. The wire is next conveyed through a solution of weak sal-ammoniac or muriatic acid; this is effected by passing it down into a trough filled with the liquid, turning it over two rollers immersed therein; it is then conveyed to the bath

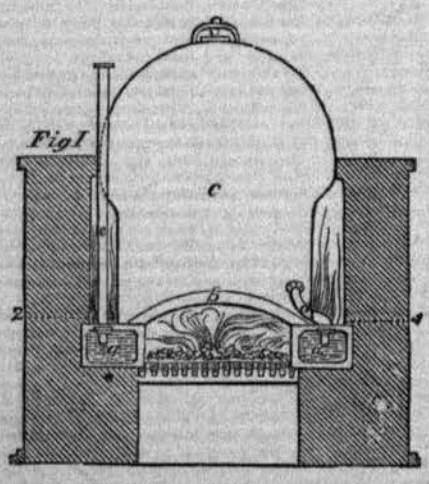
of metal with which it is intended to be coated, and from thence to reels, on which it is to be wound; these having motion communicated to them from some primary moving power, effectually pull it through the different machines, by which it is cleansed as hereinbefore described.

Having thus set forth the nature of his invention, and the manner of carrying the same into effect, he wishes it to be understood, that although he has described it as being peculiarly applicable to iron wire, used for telegraphic purposes, he does not confine himself thereto, as it is equally well adapted for steel wire; and the second part thereof, preparatory to receiving a coat of other metal, may be applied to various other descriptions of wire. He claims, first, the welding iron bars end to end, scarf-wise, and afterwards drawing them through suitable machinery, with regard to the order in which the same is performed; second, the cleansing the surface of wire by the machinery before described, preparatory to receiving a coating of zinc, tin, or other metal suitable for the prevention of oxidation.

STEAM BOILERS.

GEORE LODGE, of Leeds, Yorkshire, engineer, for "*Improvements in heating water, generating steam, and saving fuel.*"—Granted August 10, 1846; Enrolled February 10, 1847.—(Reported in *Newton's London Journal.*)

This invention consists in an improved arrangement of apparatus whereby the heating of water may be economically effected (an increased heating surface being exposed to the action of the flame and heated gases), and a large supply of steam may be quickly generated. The apparatus employed for this purpose is shown in figs. 1 and 2, as applied to a furnace in conjunction with an ordinary wagon-shaped boiler. It consists of two rectangular vessels or chambers of iron, set parallel to each other, one on either side of the fire-place, and connected together in front by a hollow arch, made also of iron. These vessels or chambers are intended to receive the water from the force pump, and, by means of pipes, with which they are provided, to conduct the water over a considerable heating surface before it enters the wagon-shaped boiler. Fig. 1, is a sectional elevation of a furnace,



fitted according to the invention, the front end plates of the chambers before-mentioned being removed; and fig. 2, is a sectional plan of the improved generating apparatus, taken in the line 1, 2, of fig. 1. *a, a,*

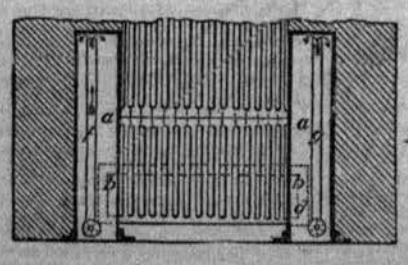


Fig 2

are the two rectangular chambers, through which the water passes on its way to the boiler. It is obvious that these chambers may be of a cylindrical or other required form, but the construction shown in the drawing is preferred, as an extensive heating surface is thereby presented to the fire. *b*, is the hollow arch, connecting the two chambers together, and forming a passage for the water from one chamber to the other; *c*, is the boiler, resting on the chambers *a, a,* and connected to the chamber *a*, by a pipe *d*; *e*, is a pipe leading from the supply-pump to the chamber *a*; and *f*, is a pipe within the chamber *a*, and forming a continuation to the pipe *e*, for the purpose of conducting the water, as it is supplied by the force-pump, to the opposite end of the chamber at which it enters, as shown by the arrows in fig. 2. The other chamber *a*, is similarly provided with a pipe *g*, forming a continuation of the pipe *d*, and having an open end near the back end of that chamber. By this arrangement it will be understood that the water, as it enters at the pipe *e*, will flow along the pipe *f*, to the back end of the chamber *a*; it will then return to the front, and, by the continued action of the pump, be made to rise up the hollow arch *b*, and pass into the chamber *a*. When it has traversed the length of that chamber, it will enter the pipe *g*, and, passing forward, will rise up the pipe *d*, and flow into the boiler in a heated state.

On referring to the elevation, fig. 1, it will be seen that the boiler is fixed so that the play of the flame around it will be precisely the same as in the ordinary mode of setting such boilers; the heat is therefore as economically employed with regard to its action on the water in the boiler as heretofore. The chambers *a, a,* (which occupy the place hitherto filled with solid brick-work for supporting the boiler) will therefore, in exposing the water on its passage to the boiler to the action of the fire, cause it to take up a considerable portion of heat that might otherwise be lost; and as the water is thus submitted to the fire in a comparatively small body, it will become quickly heated, and, entering the boiler in that state, will speedily be converted into steam.

The patentee claims the improved arrangement, above described, for raising the temperature of water on its passage to the boiler, whereby steam may be more quickly generated than by conveying the water directly from the well or supply-cistern to the boiler, and also an economy of fuel will result.

VALVES FOR SEWERS.

JAMES LYSANDER HALE, of Hackney, Middlesex, civil engineer, for "*certain improvements in sewerage and drainage, and apparatus connected therewith, parts of which are applicable to steam-engines.*"—Granted October 27, 1846; Enrolled April 27, 1847.

The improvements relate to preventing the escape of noxious air, vapours, steam, gas, &c., from drains, engines, &c., and obviating the corrosion of the hinges used in apparatus connected therewith. For this purpose, instead of forming the common traps for drains of iron, as usual, the inventor makes the frame of brown earthenware or other suitable lasting and non-corroding substance, placed in the usual way at the entrance to the drain. The valve is constructed of a piece of vulcanized india-rubber, large enough to cover the opening of the trap, and to give sufficient lap; the edge is secured to the frame of earthenware by rivets, or cement manufactured for similar purposes, by the Kamptulicon Company. The sheet of vulcanized india-rubber has a metal plate, or a stone, placed on the back, which, by its weight, keeps the face of the valve close to its seat.

Another trap for sewers is made with a number of bars on the back, instead of the metal plate or stone as above described; the vulcanized india-rubber is affixed to the earthen frame as before; the bars are secured by cement or rivets, in the direction or length of the part secured, forming the hinge; the water, as it issues from the pipe into the sewer, only raises the valve to the extent necessary to admit of the passage of the water escaping; the space between each bar forming a hinge, on which each bar moves, consequently there is no room for the escape of noxious vapours, the valves being always closed down to the surface of the water. The metal for the bars the patentee prefers is galvanised, or tinned iron.

The next improvement is for a ventilator, to be placed on the top of flues leading from places requiring ventilation—consisting of two cylinders of galvanised sheet iron or zinc, of different diameters; the smallest is placed on the top of the chimney; it has several openings in the sides near the upper end; the top is closed by a plate of metal; the large cylinder is only about half the length of the other, but at the same time sufficient to protect the openings in the smaller one (over which it is placed) from side currents, while, at the same time, space sufficient for the escape of smoke or vapour is allowed between the two; the external cylinder is supported from the smaller one by stays, and in such a way as not to obstruct the passage between them.

RAILWAY EXPENDITURE.

RETURN, *to an order of the House of Commons, showing the Amount of Money expended in the actual Cost of Construction, and of Working Stock (including Locomotive Engines, Carriages, Tools, &c.) of all* RAILWAYS *in* GREAT BRITAIN *and* IRELAND, *in each Triennial Period, previous to the 1st day of January respectively, in the Years* 1841, 1844, *and* 1847.—[Fractional Parts of a Pound are omitted.]

Railways Opened.	Construction of Railway.			Purchase of Working Stock.		
	Previous to 1841.	1841 to 1843 inclusive.	1844 to 1846, both inclusive.	Previous to 1841.	1841 to 1843 inclusive.	1844 to 1846, both inclusive.
	£	£	£	£	£	£
Aberdare	—	—	50,580	—	—	7,193
Arbroath and Forfar	117,177	3,981	4,174	14,467	2,563	538
Ardrossan	71,829	26,610	7,971	2,750	2,494	913
Ballochney[1]	57,224	23,717	9,772[1]	5,673	6,355	1,939[1]
Brighton and Chichester[2]	—	—	410,562	—	—	—
Bristol and Exeter						
Chester and Birkenhead	362,137	83,269	162,985	26,670	3,155	20,805
Chester and Holyhead[3]	—	—	1,369,808	—	—	—
Clarence[4]	375,064	127,955	6,328	12,115	1,220	—
Dublin and Drogheda	27,483	282,229	220,379	—	—	68,691
Dublin and Kingstown						
Dundee and Arbroath	88,748	13,145	1,546	14,863	4,565	1,225
Dundee and Newtyle	2,226	2,247	3,737	1,936	1,943	1,786
East Lancashire	—	215	764,851	—	—	49,350
Eastern Counties	1,382,497	1,204,765	2,015,607	46,539	65,462	329,720
Northern and Eastern[5]	146,229	328,160	51,710	24,957	56,292	123
Edinburgh and Glasgow[6]	633,683	828,493	287,788	—	126,640	58,090
Edinburgh, Leith, and Granton[7] ..	45,872	43,819	203,545	—	1,805	6,091
Eastern Union	—	—	313,229	—	—	23,394
Furness	—	—	111,439	—	—	14,336
Gravesend and Rochester[8]	—	—	71,487	—	—	13,827
Glasgow and Paisley Joint Line[9] ..	264,744	57,620	5,535	—	—	—
Glasgow, Paisley, and Greenock ..	507,066	195,142	59,207	7,045	50,391	10,576
Glasgow, Paisley, Kilmarnock, and Ayr[10] ..	537,957	268,819	41,185 265844	32,166	51,738	95,775
Glasgow, Garnkirk, and Coatbridge[11] ..	123,720	48,685	94,890	13,220	2,980	17,728
Great North of England, Clarence, and Hartlepool Junction[12]	46,043	11,666	33,003	—	—	—
Great Western[13]	4,988,823	1,135,639	271,106			
Cheltenham and Great Western ..	230,000	150,521	585,146			
Oxford Railway	—	20,029	141,259	299,221	254,444	121,324
Berks and Hants	—	—	444,943			
Oxford and Rugby	—	—	357,586			
Monmouth and Hereford ..	—	—	102,408			
Great Southern and Western (Ireland)	—	—	1,215,458	—	—	128,260
Hartlepool Dock and Railway[14] ..	381,724	80,725	15,902	—	—	—
Hayle (now West Cornwall) ..	93,281	—	—	19,593	—	—
Hull and Selby[15]	484,898	113,569	14,995	35,512	34,284	22,637
Ipswich and Bury St. Edmunds ..	—	—	301,643	—	—	2,125
Kendal and Windermere[16] ..	—	—	100,721	—	—	—
Lancaster and Carlisle	—	—	1,105,559	—	—	2,378
Llanelly Dock and Railway ..	94,541	6,869	1,145	5,829	9,661	2,035
Lancaster and Preston[17]	355,385	85,112	—	1,075	17,991	—
London and Blackwall	238,360	145,843	3,048	47,718	27,880	—
London, Brighton, and South Coast[18]	2,197,089	1,063,596	1,696,306	52,244	140,352	135,860
London and South Western[19] ..	1,737,095	221,284	25,712	546,743	87,145	16,847
London and North Western[20] ..	5,442,530	385,240	2,102,621	349,945	—	140,019
Lynn and Dereham	—	—	98,389	—	—	10,077
Lynn and Ely	—	—	215,589	—	—	10,700
Manchester, Sheffield, & Lincolnshire[21]	173,523	533,084	845,826	—	32,840	92,836
Maryport and Carlisle	74,796	166,421	142,291	4,036	8,595	18,756
Middlesborough and Redcar ..	—	—	60,489	—	—	—
Midland	4,911,846	812,582	1,454,158	333,083	142,962	207,644
Monkland and Kirkintilloch ..	122,436	48,775	9,464[22]	12,318	11,621	189[22]
Newcastle and Carlisle[23]	716,252	63,264	91,245	59,434	19,642	44,095
Newcastle and North Shields[24] ..	254,485	12,768	10,591	15,505	2,895	3,449
Norfolk	—	124,539	792,923	—	—	136,367
North British, including Edinburgh and Dalkeith[25]	—	—	1,045,009 141,710	—	—	122,217
North Union[26]	531,715	569,542	1,016,795	38,005	45,292	55,145
Newcastle and Berwick	—	—	682,670	—	—	34,043
Paisley and Renfrew	25,327	—	—	4,030	—	—
Preston and Wyre	268,355	67,293	91,511	6,592	10,963	21,749
Pontop and South Shields[27] ..	277,850	—	—	27,500	1,725	6,887
Saint Helens[28]	149,168	1,511	14,861	9,080	—	—
Scottish Midland Junction[29] ..	—	—	167,035	—	—	—
Shrewsbury and Chester	—	—	397,550	—	—	39,313
South Devon[30]	—	—	829,154	—	—	212,950
South Eastern[31]	364,406	2,133,556	2,968,959	—	117,321	304,169
Slamannan	116,368	13,857	3,612[32]	7,526	5,847	122
Stockton and Darlington[33] ..	23,624	10,733	65,541	15,363	8,440	31,964
Stockton and Hartlepool[34] ..	229,774	—	—	10,105	—	—
Taff Vale	310,167	127,568	87,298	9,863	19,744	37,992
Ulster	45,556	219,313	57,934	10,473	20,676	15,851
Whitehaven Junction	—	—	109,118	—	—	6,849
Wilsontown, Morningside, and Coltness	—	47,868	28,000	—	—	13,524
York and Newcastle	—	159,576	319,250	—	—	134,065
York and North Midland[35] ..	370,183	98,101	943,132	28,670	43,102	148,808

Remarks.

1 These sums are the amount expended to the 29th March, 1845; after which the Monkland and Kirkintilloch, Ballochney, and Slamannan Railways were wrought together by mutual agreement. The amount expended upon the whole, since 29th March 1845 to 30th January 1847, is, for construction, 12,542*l.*; for stock, 16,857*l.*

2 This sum includes 220,480*l.* for the Portsmouth Extension.

3 London and North Western Company will probably find working stock for this Line, and take up the contracts of the Company for 50 engines; cost 107,000*l.* None yet delivered, nor any payment made on account. No contracts entered into for carriage stock.

4 Working stock sold for about 9,000*l.* in 1844 to the Stockton and Hartlepool Railway Company.

5 Amalgamated with Eastern Counties, 1st Jan. 1844.

6 Cost of land, compensation, and Parliamentary expenses, are included in the cost of construction. There was also 15,274*l.* paid for Parliamentary expenses for Branch Lines in 1845 and 1846. Cost of formation of Junction with Monkland and Kirkintilloch Railway, 31st Jan. 1844 to 31st Jan. 1845, 297*0l.* Payments in 1846, on account of Campsie Branch, now in course of construction, 3956*l.* Payments in 1845 and 1846, on account of Slamannan Junction Railway, nearly complete, 8,598*l.*

7 Price of land included in cost of construction. Line nearly completed. Works commenced some years previous to 1841, but suspended for a time.

8 Exclusive of cost of Canal.

9 The expenditure is calculated on the return made by the Glasgow, Paisley, Kilmarnock, and Ayr Railway Company. The Line belongs jointly to the Glasgow, Paisley, and Greenock, and Glasgow, Paisley, Kilmarnock, and Ayr, having no working stock of its own.

10 Main Line from Paisley to Ayr, including branch to Kilmarnock. New Branches and Extensions under construction. One half cost of joint Line between Glasgow; other half paid by Greenock Railway company.

11 Amalgamated by purchase with the Caledonian.

12 Engines and wagons for coals, &c. furnished by respective collieries.

13 The working stock for other Lines worked by the Great Western Company is included in these charges. (See separate return for expenditure prior to 1841.)

14 Engines and wagons for coals furnished by respective collieries.

15 Return made up to end of 1845; since which time the Line has been under the management of the York and North Midland Company, to whom it is leased.

16 The working stock of this Line is furnished by the London and North Western Company, at fixed rates.

17 The Company having granted a lease of the Railway to the Lancaster Canal Company in 1843, can make no return of expenditure since that date.

18 This return includes the London and Brighton, London and Croydon, Brighton and Chichester, and Brighton, Lewes, and Hastings. The item in first column varies from printed accounts by 175,780*l.*, amount of Parliamentary expenses of opposing Companies, subsequently amalgamated under the title of London and Brighton Railway; for the aggregate amount of expenditure of which, previous to 1841, see separate return.

19 Including Parliamentary and all other expenses.—(See separate return for detailed account of expenditure prior to the year 1841.)

20 (See separate return.) Southern division, including the following Branches: Warwick and Leamington; Northampton and Peterborough; Aylesbury; Dunstable: Rugby and Stamford; Rugby and Leamington; Trent Valley.

21 The late Sheffield, Ashton, and Manchester.

22 These sums are the amounts expended to 29th March 1845.—(See Ballochney return.)

23 Previous to 1837, 491,257*l.* expended in construction, and in working stock 29,602*l.*; these sums appear in the totals under their proper columns. In the last column an estimate has been made as to how much of the works commenced in 1846, and now in progress, should be therein included.

24 This Line being amalgamated with the Newcastle and Berwick since 30th June 1846, amounts laid out in construction and working stock for this Line, for half-year ending December 1846, are included in the latter Line's return.

25 This return includes a large amount expended on Edinburgh station, and workshops for Hawick Extension, and construction of Branches connected therewith; also in surplus property purchased and to be resold.

26 The third column includes cost of Bolton and Preston, then amalgamated with this Line.

27 In addition to the Company's stock, stock belonging to other parties, estimated at 25,500*l.*, was rented by the Company previous to 1841.

28 Original cost of working stock is mixed up with construction, but the return is the ascertained value in 1841

29 No working stock purchased; Line proposed to be worked by a contiguous Line; terms still open.

30 Working stock includes cost of atmospheric tube, &c., and also 2,500*l.* for electric telegraph.

31 Engines, carriages, wagons, buildings, machinery, and tools, included in working stock.

32 These amounts were expended to 29th March 1845; see Ballochney return.

33 Amount of construction not included; chiefly for heavier rails, new bridges, extensions in sidings, &c. &c.

34 Line sold to Leeds and Thirsk for 240,000*l.*

35 Price of land and Parliam. expenses not included.

Cost of Various Railways Previous to 1841.

Return *showing the Sums of Money actually expended by the following Railway Companies previous to* 1841:—Great Western, South Western, Brighton, and North Western (Southern Division); *likewise the Aggregate Sum expended by the above mentioned Railway Companies in each Year previous to* 1841:—

Year.	Great Western.	London and South Western.	London and Brighton.	London and North Western (Southern Division.)
	£	£	£	£
1833	..	..	..	48,943
1834	..	24,754	..	277,742
1835	93,520	150,780	..	727,956
1836	350,983	385,557	..	1,230,679
1837	966,574	385,952	..	1,696,508
1838	1,196,530	609,251	384,831	1,036,990
1839	1,157,893	402,061	548,072	579,723
1840	1,522,544	325,482	758,477	193,934
Total	5,288,044	2,283,837	1,691,380	5,792,475

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

ON THE MANUFACTURE OF CASKS AND VESSELS, AND SEASONING TIMBER.

At the Western Literary Institution, Leicester-square, May 3, the following paper was read, "*On the Manufacture of Casks and Vessels, more particularly those used by Brewers, and on the various methods adopted for Cleansing and Purifying such Vessels*":—*

When it is borne in mind that in some establishments in London, there are no fewer than from 70,000 to 80,000 casks employed in sending out beer only; and when it is further believed that in the United Kingdom for public brewing alone, there cannot be less than 2,600,000 of such vessels in use,—the subject of keeping them in a fit and proper condition for the purpose for which they are intended, becomes one of immense importance.

It would be folly to say that the subject has not had much attention devoted to it. Large sums of money have been expended in fitting up various kinds of machinery for this purpose. Many persons incur great expense in removing a head of each cask and thoroughly scouring and cleaning them; also "firing," steaming, the use of chemicals, and other means have been resorted to, in order to effect the great *desideratum* of clean and sweet casks; but after all, the greatest difficulty is experienced in effecting this, and a serious loss of property is oftentimes the consequence.

Before going more fully into the subject, it is necessary that the various methods which have hitherto been adopted and which are still in use, should be fully explained, and we will consider in the first place, unheading casks.

Removing the head of a cask is no doubt the surest and best mode, so far as regards getting it clean, and one which, in many establishments, is carried out completely at no small expense for labour, damage to heads, grooves, hoops, &c. These drawbacks, great as they are, might be overlooked, provided by such means they could be insured as sweet. But this by no means always happens; there is then the alternative of either allowing it to remain (without the head) for a considerable length of time exposed to the sun's rays, or extreme frost, or subject it at once to the—

"Firing process,"—which is that of placing of what is called a "cresset," containing fire inside the cask, and thus heating the wood until the "must," or mouldy smell is destroyed. During this process it not unfrequently occurs that a piece of burning wood drops upon the bottom head of the cask, or perhaps the flame reaches to the sides, and hence charring takes place, in all probability, to a serious extent, and if so, a non-conductor is thus formed, which must necessarily prevent any taint still existing in the body of the wood, from being evaporated. Casks so treated are often found to give out a pernicious flavour to the beer or other liquid, with which they may be afterwards charged, to the serious loss of the brewer, inasmuch as he may have to pay double freightage or carriage on "returned beer," if not the entire loss of it; besides the repetition of the above ruinous process, which is admitted by those who adopt it, as only advisable in extreme cases. The next process is that of

"Steaming."—For this purpose many brewers have boilers of large capacity, in which is generated steam of 3 or 4 lb. pressure, connected to a pipe leading all round, or by the sides of a building, with nozzles inserted in the same, about 2 ft. 6 in. apart, or according to the diameter of vessels requiring to be steamed. These nozzles, on being inserted into the bung-holes, have the pressure of the steam forced through them into the casks, in many cases for 3 or 4 hours consecutively, but the more common period is two hours. This is for the purpose of cleansing as well as sweetening casks, and as a substitute for the more expensive process of unheading. Now the effect of this is, in the first place, to swell and surcharge the pores of the wood with moisture, to force into the blisters any mouldy solution, or taint, which may have been previously within a line's thickness of the stave, a considerable distance further into the body of the wood. As a proof of this being the case, it is perfectly well known that where the system is carried on, casks must not remain beyond 36 hours before being filled with beer, otherwise spots of mould will make their appearance, and all the flavour will again return to the inside of the cask; clearly showing that the germs of the disease have not been destroyed, but simply withdrawn behind the screen, to return in all probability, with increased violence. Can mould and disease be so near at hand and yet the beer not partake of it?

Steaming frequently causes the complete fracture of the staves, on account of the expansion which necessarily takes place; the fibres of the wood are destroyed, the resins and other solid matters which bind the fibres together are gradually washed away, and each successive steaming, when carried to excess, has been known to charge the pores of the wood with 3 lb. weight, or nearly the third of a gallon of water, which on coming into contact with the remains of the beer (after the cask has been emptied) then, most likely, in an acid state, very speedily generates mould, as proved by M. Dutrochet, who says—"that a drop of acid in an ounce of water produced mould in eight days." But independent of the presence of acid, water left in the pores of the wood is sufficient of itself in certain situations to create decomposition, and all the worst evils of which the brewer and others have to complain. But after all, that steaming will not cleanse a cask, has been proved on several occasions. When mouldy casks have been subjected to it for upwards of two hours, it has been found upon unheading them that they have been in a slimy and filthy condition. Scalding and "blowing off," as it is termed, have then been resorted to, but still the casks could not be considered clean inside; that which appeared before the steaming as mould, had afterwards the appearance of glue.

There is another very important matter as regards damp being allowed to remain in any vessel intended for the reception of beer. Take the simple fact of its being put into a wet jug, or glass—do we not at once find it "flat," and out of condition? Indeed, so much so that those, whose trade it is to bottle beer, are compelled to be exceedingly particular in having the bottles perfectly dry. If it is thus necessary in the one case, surely it must be so to some extent in the other.

With regard to the sweetening the casks by chemicals, the methods are as numerous as they are varied. Some use common salt, others soda, lime, sulphuric acid, muriatic acid, leys made of ash, beech, or other hard wood, ashes, together with boiling water in abundance, and many other expedients, all of which are attended with labour in the first instance, and unheading and scouring the cask. Much time is afterwards spent in waiting for these solutions taking effect; and after all this, there is perhaps an odour left quite as bad as the original one which they were intended to cure. The result is, that frequent scaldings with hot water or steam become necessary, and the cask is finally left in the best possible condition to generate mould and other evils.

The machinery in its simplest form for cleansing casks, has hitherto been that of a common chain, or, in some instance, a "mail"-chain, placed inside the cask, with two or three gallons of hot water, and the cask afterwards rolled about in a backward and forward direction, until it was considered to be sufficiently cleansed; but this has been found uncertain in its results, there being no proof whatever of the chain having traversed over the whole of the surface, and particularly in the angles of the heads. This process, therefore, is not to be depended upon.

A piece of machinery was invented a few years since, to work either by hand or engine power. It consisted of frames or cradles at right angles to each other, on one continued shaft, the frames being attached at the diagonal points, the casks thus lying in an oblique position, and secured to the frames or cradles by means of a strap and set-screw; a common chain was placed inside for the purpose of cleansing, but owing to the continuous angular movement of the cask, the chain only acted partially on the surface; it was therefore necessary to shift it several times before anything like a clean cask could, by this method be obtained; so that, from the labour in shifting, added to the uncertainty of having a clean cask, the invention met with very little encouragement.

There was another fitted up some years since at a large establishment in South Wales, at an expense of £1,500, and which is still in use. It consisted of a series of jointed brushes, which are made to revolve horizontally; one head of each cask being taken out, the cask is put upon a truck (or something of that kind), and pushed towards the brush, which, going at considerable velocity, removes the adhering matters, but owing to the inequality of thickness of the staves, the brushes leave a considerable quantity of dirt in the angles, which has afterwards to be scraped or brushed out with scrubbing brushes, the latter operation being performed by women employed expressly for this work; as many as 400 casks per day being thus cleaned, and after being headed up again, are, in cases of must or smell, subjected to steam, the use of soda, &c., as previously alluded to, at no little expense for damage done to casks, besides the wear and tear of brushes, which is very great.

Having pointed out the evil effects of firing, hard steaming, the use of chemicals, and other methods, as well as the attempts which have been made at machinery, to render casks in a fit and proper condition to contain

* We are indebted for this Report to the "Patent Journal."

beer, &c., we will now proceed to describe the process lately invented by Davison and Symington.

The invention relates—1st, to a new method of making casks; 2ndly, to a new method of cleansing casks by machinery; 3rdly, to a method of purifying casks. On the improved mode of making casks;—but first a few words on the present plans. According to the present mode, the master cooper being desirous of sending to his customers only such as are made of pure and well-seasoned wood, is compelled to lay by the wood for a considerable period, in some cases two or three years. Now, after this, the wood is, no doubt, freed from much of its moisture; some of the vegetable juices have been evaporated by exposure to the sun and wind; but it should be remembered that the wood in this state is much harder to bend than it was in its former green state, so much so, that frequent applications of water, assisted by heat, are obliged to be made, before the necessary bending can be accomplished; with all the care that can be bestowed, the staves frequently crack in the cross way of the wood, which, if not through the entire thickness, exhibits itself in the inside in the form of a blister, many of which may sometimes be found in one cask, to the great annoyance of the brewer and those whose business it is to see that the casks are in a fit state to contain beer or other liquids, as it most frequently happens, that when moisture is admitted into these casks, the listers expand, and form a receptacle for any vegetable or other matter which may deposit itself from the contents of the cask, and by subsequent exposure to the atmosphere soon become mouldy, if not in a musty state; hence the plea of the coopers when they say—"We must un-head the cask to chip out the blisters."

To avoid this expensive and injurious process, as well as to render casks in a much better seasoned state than by long exposure to the atmosphere, it is proposed to make use of wood in its new or green state, that is, when the vegetable juices are in the pores, in which state the staves are easily bent to the desired curvature, without cracking or otherwise injuring the staves; after being thus bent in the form of casks with temporary hoops, making due allowance for shrinkage, they are in this state to be subjected to the action of a continuous and rapid current of heated air passing through the interior of the cask (the cask being supplied with a temporary cover over the top end, with a small hole in the same for the exit of the air), until the wood has exhaled all its natural sap or other aqueous matters with which it was formerly impregnated; the staves thus become denser and harder, all the fibres being brought closer together; this done, the casks are finally hooped and finished off in the usual way, the wood of which the heads are composed having been previously seasoned in a similar manner, in chambers properly constructed for the purpose. Casks so made are rendered entirely free from sap and other moisture, hence their peculiar fitness for warm climates; and whilst it is of great importance for some kinds of beer to have the casks free from all coloured juices, it is equally so for other articles, such as bread, beef, &c. In proof of the heated air so removing these aqueous matters, Dr. D. B. Reid, who was professionally engaged to investigate the merits of this invention, states—"A new cask of green wood, subjected to the action of heated air, gives out a volatile matter along with a large quantity of water, which, when condensed in a refrigerator, sustained at a low temperature by a freezing mixture, presents a liquid, limpid and colourless, like water, but strongly impregnated with the odour of the wood. Also, the wood not only becomes denser, but has less taste, at least at first, and must necessarily vary in its texture, according to the extent to which it has been heated, and the amount of moisture expelled."

The new cleansing machines consist of two frames made of iron, one revolving inside the other; the inner may be termed a cradle, in which the cask is secured by means of a chain, lever, and catch; motion being given to the outer frame, either by hand or engine power, causes the inner one to revolve in a contrary direction, which is accomplished by an eccentric next the axis of the outer frame, and to which is connected a set of jointed rods communicating with a ratchet, which is fixed on the axis of the inner frame. The action is thus:—for every turn the outer frame makes in the direction of its length, the inner one, which contains the cask, moves at right angles with the other frame, a distance equal to one tooth of the ratchet, or 1-20th of the circumference of the cask; in this way, by the time the outer frame with the cask has made twenty revolutions end over end, the inner frame has moved the cask round only once sideways. Thus by means of a chain of peculiar construction, attached to a plug suited to the bung hole, which is in the first instance inserted in the cask, together with two or three gallons of hot water, every inch of surface becomes acted upon and freed from all adhering matter in a very short time. For the purpose of more thoroughly cleansing a very bad cask, it is usual, after it has revolved for about a quarter of an hour, to loosen the plug, and allow the first water and dirt to run out; then, from a main over the machines, to let in about a gallon of clean hot water, for the purpose of giving a second rinse. The very worst description of casks are, by this process, rendered perfectly clean in the course of half an hour. It is only necessary further to observe, that any number of machines may be made to revolve at the same time, by applying adequate power.

To test the merits of this part of the invention, a great number of very interesting experiments were gone into, some of which were made immediately under the direction of Dr. Reid, from which it would appear that rapid currents of heated air in passing through a mouldy cask becomes loaded not only with moisture, but also with minute particles of mould, or at all events, with some material from the mould, which is proved to develope mould into other substances; which was ascertained by condensing the vapour which passed from a mouldy cask, by a current of heated air, being found to deposit on the corks of the bottles containing the liquid, a very rich vegetation of mould, whilst no such appearance was traced in the liquid condensed from fresh casks; showing that the fact refered to is one of the greatest importance, as indicating that the action of heated air is not merely exsiccative but that it does dissipate mould.

Dry heat is a well known purifier, it having been satisfactorily proved lately in Syria, that even the clothes worn by persons who had died of the plague, were rendered perfectly harmless by being exposed to 230° Fah.; but lest this should be going too far away from the subject in question, one or two other simple circumstances may be mentioned, as showing that dry heat is the thing needed between the fibres of the wood; take for instance a chip from a musty cask, and carry it in the waistcoat pocket for an hour or more, and it will be found that the warmth of the body alone has materially, if not wholly, removed the unpleasant odour. In the process of firing a cask, it was found that the average heat from the cresset against the sides of the cask, was equal to 350°, and the application of this temperature for half an hour is usually considered sufficient to remove the moisture and smell; but great difficulty is experienced in applying the heat uniformly, and it is at all times too sudden to effect a complete removal of the moisture and taint from the body of the wood, in addition to the ill effects of charring. The new process insures one temperature throughout every portion of the cask, and as it requires only five seconds of time (from the rapidity with which the air is propelled) to give every crevice of a 36 gallon cask a fresh supply of heat, it will be readily understood that by such means, all danger of the wood being burnt is removed, the cask becoming gradually and speedily deprived of all moisture, and with it the complete evaporation of the "must" with which that moisture is impregnated.

Contrary to the opinions of some, this process is not attended with any injurious effects upon the wood, but the very reverse; it being found to close the pores and render the surface much harder, and consequently less susceptible of re imbibing moisture, and which would be particularly so if steam could be altogether abandoned in the process of cask cleaning; the residue of the beer would then become hardened in the pores upon each application of heated air, and would eventually effect an internal protecting crust or glaze on the surface, which would materially facilitate the future cleansing of the casks.

The advantages of the new system are these:—First, that casks can be made out of green wood instead of very dry and seasoned wood, and by this means be free from blisters, and in every way better fitted to resist moisture and its evil consequences. Secondly, that the cleaning of casks may be effected by machinery, with every degree of certainty, without unheading or otherwise destroying the constitution of the casks. Thirdly, that casks may be rendered sweet, pure, and uniformly dry, without the injurious effects of either un-heading, the use of chemicals, or hard steaming. Lastly, that the means by which the whole is accomplished, are not only simple, speedy, and to be depended upon, but at one-fourth the expense of any other system where un-heading is resorted to.

The heating apparatus consists of 15 cast iron pipes of a horse-shoe form—the internal sectional area of each being 12 inches, and the external heating surface 1665 superficial inches—these drop into sockets connected with a horizontal pipe, of 9 inches diameter, which is placed on each side of the surface, and the divisions in the latter are so arranged that the air in its passage towards the nozzles first passes through four of the horse-shoe pipes; next five, and then six, pipes; this is for the purpose of making room for the expansion of the air, which, it will be observed, has by this time passed three times over the furnace. The air on passing away from the six pipes immediately rushes through the nozzles, and from thence to the interior of the casks over which they are placed. The air is propelled by means of a fan of 18 inches diameter, at a speed of 1,400 revolutions per minute. The apparatus is also furnished with a boiler which is placed over the heating-pipes, the external heat of which tends greatly to forward the generation of steam, which is used for the purpose of warming and slighly moistening the casks previous to being finished off with the heated air. The water in the boiler serves for charging the casks during the cleansing process, as before described.

An apparatus such as now described, consisting of cleansing machines, and 21 nozzles, for heated air, has been in operation at Messrs. Truman, Hanbury, Buxton, and Co.'s brewery for upwards of two years, during which time upwards of 70,000 mouldy casks have been cleansed and purified; a great proportion of which would have required, under the old system, to have been either unheaded, and remained so for a considerable time, or have been subjected both to "firing" and hard steaming, at an expense of at least 10d. per cask. The apparatus alluded to is capable of cleansing and purifying 220 casks per day, or 1,320 per week, at an expense as under, viz.:—

Fuel for furnace, 2½ tons, at 22s.	2	15	0
Proportion of fuel to engines, 12 cwt.		13	3
2 men and 1 boy, but say 3 labourers, to attend to machines and hot air apparatus, each 20s.	3	0	0
Total . .	£6	8	3

Or under 1½d. per cask.

This does not include the interest of money sunk in fitting up the apparatus, or the cost of wear and tear; but including the whole after two

years' hard working of the apparatus, it is found that each cask (including butts, puncheons, and the larger description of casks), exceeds little beyond 2½d., or one-fourth what it costs by the present system.

Wood seasoned by this process is particularly applicable to floor boards, and house fittings generally, for cabinet work, musical instruments, carriage building, &c., as shown by the annexed table:—

Comparative Strength of Various kinds of Wood in a "Seasoned" and "Unseasoned" state.

	Names of Wood 4·0 bearing 1 inch square.	Weight.	Weight after Hot Air.	moisture removed	Deflection in inches & tenths.	Breaking Weight in lbs.	
1	Fir seasoned..	1·16	1·09	·07	2·5	201	
2	do.....	1·17	1·08	·09	3·3	190	8·8 or nearly 9 per cent. added to strength of Fir by seasoning.
3	do.....	1·19	1·1	·09	4·0	214	
4	Fir not seasd. .	1·18	—	—	3·6	190	
5	do.....	1·15	—	—	3·8	190	
6	do.....	1·05	—	—	4·0	176	
1	Elm seasoned.	1·33	1·21	·12	3·5	120	
2	do.....	1·3	1·18	·12	5·	106	12·3 per cent. added to strength of Elm by seasoning.
3	do.....	1·4	1 27	·13	4·3	128	
4	Elm not seasd.	1·15	—	—	6·5	106	
5	do.....	1·21	—	—	5·7	99	
6	do.....	1·36	—	—	6·1	110	
1	Ash seasoned .	1·56	1·44	·12	4·	234	
2	do.....	1·51	1·38	·13	6·8	252	44·7 per cent. added to strength of Ash by seasoning.
3	do.....	1·46	1·33	·13	6·1	248	
4	Ash not seasd.	1·41	—	—	8·	176	
5	do.....	1·38	—	—	8·5	162	
6	do.....	1·34	—	—	8·	169	
1	Beech seasond.	1·85	1·71	·14	5·	257	
2	do.....	1·76	1·62	·14	5·	279	61·9 per cent. added to strength of Beech by seasoning.
3	do.....	1·81	1·63	·18	5·	280	
4	Beech not seas.	1·73	—	—	7·5	176	
5	do.....	1·8	—	—	7·	180	
6	do.....	1·78	—	—	5·5	148	
1	Oak seasoned .	1·88	1·73	·15	6·	299	
2	do.....	1·88	1·77	·11	5·	270	26·1 per cent. added to strength of Oak by seasoning.
3	do.....	1·45	1·36	·09	—	—	
4	Oak not seasd.	1·84	—	—	6·2	218	
5	do.....	1·89	—	—	6·9	227	
6	do.....	1·85	—	—	6·	232	

AGE OF VOLCANOES.

At the Royal Institution, April 30, W. R. Hamilton, Esq., in the chair, a paper was read "*On the Age of the Volcanoes of Auvergne as determined by the Remains of successive Groups of Land Quadrupeds.*" By C. Lyell, Esq.

The region of extinct volcanoes of Auvergne derives its peculiar interest from the circumstance of its never having been submerged beneath the sea during a period in which its geological and geographical structure, and the animals and plants by which it has been inhabited, have undergone a great succession of changes. In the rest of Europe generally the volcanic rocks have either been originally of submarine origin, or the surface since they were produced has suffered so much denudation by the action of the waves of the ocean as to make it impossible for us to ascertain the form and manner in which the eruptions took place, or the relative position which the igneous formations held at first to the hills, plains, and valleys then existing. After describing the several classes of rocks in Auvergne—the granite, the eocene freshwater, and the older and modern volcanic, each depicted by different colours in an extensive landscape enlarged from a view of the valley of Chambon (Puy de Dome) by Mr. P. Scrope.—Mr. Lyell said he should dwell chiefly on the antiquity to be ascribed to the Puy de Tartaret, a type of one of the most modern cones of eruption in Central France. The comparatively recent origin of this conical hill of scoriæ, with its crater at the summit, is proved by its standing at the bottom of a deep valley excavated through the alternating beds of pumice, trachyte, and basalt, belonging to the more ancient volcano of Mont Dor, and partly through the subjacent and fundamental granite. It is farther confirmed by the course of a powerful current of lava; which, proceeding from the base of the cone, flows thirteen miles down the channel of the River Couze, stopping at the town of Nechers, near Issoire. The lava occupies the ancient river-bed, and is observed to contract in its dimensions in the narrow gorges, where it also gains in height, like the water of a river flowing through the arch of a bridge; and to expand again where the valley opens, where it spreads into a broad sheet having a level surface. It also flows up the channels of tributary streams till it attains a level corresponding with the top of the lava at the point of junction of the tributary with the main valley. But although these appearances prove that the lava has flowed as it would now do if it were remelted and made again to descend the same channel, it nevertheless bears in some part of its course the marks of considerable age.

Before considering these, Mr. Lyell entered into a short digression to refute the doctrine of the mediæval origin of the volcanoes near Clermont, advanced by a writer in the *Quarterly Review* for October 1844 (p. 295), where it is pretended that Sidonius Apollinaris, Bishop of Clermont, who flourished at the close of the fifth century, has borne explicit testimony to "the volcanic eruption, the crumbling of the cones, and the heaping up of the showers of ashes and scoria cast forth amidst the fires." The passages relied on occur in a letter from Sidonius to his contemporary, Mamertus, Bishop of Vienne, in Dauphiny, written when Auvergne was threatened with a fresh irruption of the Goths; to avert which danger the Bishop proposes to adopt certain forms of prayer (rogations or litanies), which Mamertus had already introduced on the occasion of some "prodigies" which had happened in Dauphiny sixteen years before. In alluding to these phenomena, Sidonius says that "the walls of the city of Vienne were shaken by frequent earthquakes, many fires broke out, and mounds of ashes were heaped up over the fallen copings of the walls." "Nam modo scenæ mœnium publicorum crebris terræ motibus concutiebantur, nunc ignes sæpe flammati caducas culminum cristas, superjecto favillarum monte tumulabant." Deer also took refuge in the forum, and the people fled; all but the Bishop, who had a right to reckon on divine protection, because, as Sidonius reminds him, on a former occasion, the flames at his approach had miraculously receded out of reverence to his holy person. At the time of the earthquake he (Mamertus) had told his people that their repentant tears would extinguish the fires sooner than rivers of water, and the steadfastness of their faith would cause the rocking of the ground to cease. Sidonius finishes with asking the Bishop of Vienne to send him some relics to make all secure. The style of the whole epistle is so faulty, ambitious, and poetical, as to make it difficult to know the exact value of the expressions, and dangerous to found upon them any philosophical argument about natural events. There is not a word about Auvergne, but simply an allusion to the shocks which appear to have thrown down buildings and caused (as usual in such cases where roofs fall in) great conflagrations and heaps of cinders. The terror of the wild animals when the earth rocks, and their sensitiveness to the slightest movements, are well known. Although the epistle proves Sidonius to have had a fair share of the credulity of his age, both in respect to miracles wrought in favour of a contemporary saint and the efficacy of relics, it would be unfair to charge him with a belief in the occurrence of a volcanic eruption at or near the site of the city of Vienne, which the investigation of the ablest government surveyors, to whom the construction of a geological map of France has been intrusted, has entirely disproved. There are, in fact, no monuments of volcanoes, ancient or modern, in Dauphiny; and if there had been they would not throw light on the date of eruptions in Auvergne.

But to return to the lava-stream of the Puy de Tartaret before alluded to—what geological antiquity can we assign to it? In one of the gorges the entire mass of solid basalt has been swept away by the torrent, so that the former continuity of the stony current is interrupted for several hundred yards, at a point about midway between its efflux from the cone and its termination. This implies a long period of excavation. In another place, about one mile and a half from St. Nectaire, an old Roman bridge, still passable, having two arches, each fourteen feet wide, spans a deep ravine, cut by the Couze through the middle of the lava, which is here of columnar structure. The bridge is supposed by French architects and antiquaries to be of the date of about the fifth century; yet the springing of the arches proves that when it was erected the ravine was of the same width as now. Nevertheless, while signs of denudation such as these attest the vast amount of removal of hard rock since the lava flowed and was consolidated, the contemporary cone of loose, incoherent scoriæ has stood in its exposed position at the very bottom of a valley, entire and uninjured, the rain-water being instantly absorbed by the porous mass; and no rill being allowed to collect on its flanks. It is clear that if any flood of water had passed over Auvergne, if any inundation had raised the Lake of Chambon thirty or forty feet, it must have carried away the perishable cone. The lake alluded to owes its origin to the damming up of the Couze by the volcano and by landslips which accompanied the eruption.

But the most conclusive evidence, according to Mr. Lyell, of the remoteness of the period at which the cone and lava of Tartaret originated has yet to be set forth, and has only been distinctly brought to light since he revisited Nechers in 1843, when the Abbé Croizet pointed out to him a locality near the lower extremity of the great current, where fossil bones of extinct animals had been discovered in a meadow, between the base of the lava and the channel of the Couze, now ten feet lower in level than the lava. In company with Mr. Bravard, Mr. Lyell explored the spot; and they convinced themselves that the bone-deposit passed under the lava, which here forms a mass thirty feet thick. Subsequent investigations not only confirm this view, but have enabled Mr. Bravard to obtain from beneath the stony current a considerable number of additional osseous remains, referable to the genera Equus, Sus, Tarandus, Cervus, Canis, Felis, Martes, Putorius, Sorex, Talpa, Arvicola, Spermophilus, Lagomys, Lepus, and according to Mr. Waterhouse, Cricetus or hamster, and others,

besides the remains of a frog, lizard, and snake, and the bones of several birds. Mr. Owen has examined some of these remains for Mr. Lyell, and recognises among them the *Equus fossilis* and *Tarandus priscus*, both extinct species, occurring in the caves of England, with the contents of which generally this assemblage of fossils from Auvergne appears to agree very closely—there being a predominance, according to Messrs. Croizet, Bravard, and Pomel, of species not known to exist at present with an intermixture of a few others undistinguishable from quadrupeds now inhabiting Europe. Among the land shells associated with the bones, were found *Cyclostoma elegans*, *Clausilia rugosa*, *Helix hortensis*, *H. nemoralis*, *H. lapicida*, and *H. obvoluta*—all recent, and all, with the exception of the last, now found in the immediate neighbourhood. Mr. Lyell thinks it probable that the deposit of red argillaceous sand under the lava containing these remains, was derived chiefly from volcanic matter, which the eruption of Tartaret threw out, and that the fossil animals perished by floods occasioned by that outburst. That a similar Fauna continued to live in Auvergne after the latest eruptions, is inferred from the discovery of the remains of many of the same group of animals—Spermophilus, Lepus, Castor, and others, in the clefts of a lava current as modern as that of Tartaret, observed at Aubière, near Clermont. This Fauna, so different as a whole from that now living in Europe, evidently inhabited Auvergne, when the valley of the Couze had been excavated down to the same level as that over which the lava of Tartaret flowed:—yet its antiquity must be extremely great—the gradual dying-out of species and the introduction of new ones taking place, according to Mr. Lyell's views, with extreme slowness. The fact that the shells belonged *all* to living species (which possibly might not hold good if a larger number were obtained) affords no presumption against an indefinitely remote origin as compared to the periods of history and tradition, because the lecturer has shown that the ravine of the Niagara ("Travels in N. America," vol. i. ch. 2) and the Delta of the Mississippi (Reports of the Brit. Assoc. for 1846), both of which must have required an enormous period for their formation, are, nevertheless, posterior in date to deposits full of the recent land and freshwater shells of North America, associated with the remains of quadrupeds, nearly all of which are now extinct.

It was shown that all the volcanoes of the modern class of which the Puy de Tartaret is a type, were not formed at once, for the lavas of some (as for example, at Champheix, in the same valley of the Couze) stand at a greater height above the actual river-courses and repose on ancient alluvium formed when the valleys were shallower. To allow time for the ejection of these numerous cones and lava-currents, of which there are several hundreds in Central France, we require a long series of ages, all subsequent to the miocene period, to which another class of monuments of anterior date are referable—as, for example, the bone-bearing alluviums alternating with volcanic formations (pumiceous and trachytic) of Mont Perrier, to which a distinct Fauna (of the genera mastodo, elephant, hippopotamus, tapir, &c.) belongs. Some of the valleys cut out of the still more ancient lacustrine strata were only half eroded to their present depth in the miocene period, and were occasionally filled up with miocene deposits and afterwards re-excavated. It is possible in Auvergne to distinguish the relative ages of a great variety of alluviums containing the bones of terrestrial quadrupeds, in consequence partly of their preservation under lavas of different ages, and partly their position on the sides of valleys which were gradually deepened; no flood or return of the ocean having disturbed the surface and mingled the fossils of one period with those of another, as has happened in England and most parts of Europe. The oldest Fauna of land quadrupeds in Auvergne, that found in a fossil state in freshwater strata or marl and limestone, older than the trachyte of Mont Dor, consisted of species of Paleotherium, Anoplotherium, Anthracotherium, Opossum, &c., analogous, in great part, to those of the Paris basin, with some miocene forms associated and belonging, according to Mr. Lyell, to an upper eocene group, newer than the Parisian tertiaries, or the uppermost freshwater of the Isle of Wight. Hence it follows that the whole succession of revolutions in the animate and inanimate creation which have occurred in Central France since the land emerged, vast as they are in duration, as compared to the era of the more modern volcanoes, is nevertheless, considerably posterior to the marine clay on which London is built;—this last being one of those tertiary deposits which rank as but the monuments of yesterday in the great calendar of geological chronology.

IMPURITIES OF WATER.

At the Royal Institution, *April* 16, Prof. Solly delivered a lecture "*On the Impurities of Water and the Mode of its Purification.*"

Mr. Solly described fresh water as the result of distillation from the ocean. In the progress of this operation, the vapour in the first instance, and the condensed liquid subsequently, must become contaminated with whatever foreign matters exist in the atmosphere which receives the former, and the strata of the earth on which the latter falls and through which it percolates. But even at the outset of this natural chemistry there is impurity. Alkaline salts, as Mr. Solly has already demonstrated, rise in vapour; therefore no water which is evaporated from the sea can be pure. The analysis of water is simple in theory. The gaseous or solid substances contained in, or combined with it, being detected by few tests. Before, however, the analyst has recourse to these, he attends to the physical qualities of the fluid—any odour, or colour, or taste, being at once indicative of impurity. These impurities are either *gaseous*, *organic*, or *inorganic*.—1. *Gaseous*. If common air be present in the water, it is detected by heat; if carbonic acid gas, by lime-water; sulphuretted hydrogen is discovered by its odour, and by its blackening salts of lead.—2. *Inorganic Matters*. These are either solid substances, as clay, held in suspension by organic matter or else insoluble substances held in solution by the gas that is present in the water. Thus, Carrara-water is chalk dissolved in water by the excess of carbon therein. There remain other inorganic substances, as common salt and some salts of iron, which are essentially soluble. Besides these impurities, water kept in leaden vessels often contains a trace of that metal. Mr. Solly noticed the familiar tests by which these are recognised.—3. *Organic Impurities in Water* are chiefly noxious by the sulphuretted hydrogen and ammonia which they produce, and which is usually perceptible to the senses. The effects of these various impurities were next specified. Mr. Solly explained, from the principle of saponification, how water containing salts of lime decomposes the *soluble soda or potash soap*, and forms *an insoluble lime soap*, which is useless for all purposes of washing. He quoted the opinion of some experimenters, that bicarbonate of lime rather improved than deteriorated the utility of water for culinary purposes; but he maintained that it was injurious to the vegetation of plants, in consequence of the deposit on their leaves which it left on being evaporated. Sulphate of lime is always injurious for culinary uses, inasmuch as it interferes with the solubility of many organic substances, as tea, &c. Having briefly adverted to the injury produced by the earthy impurities of water when they are deposited in water-pipes, boilers of steam-vessels, &c., Mr. Solly lastly suggested various methods of freeing water from the impurities which he had described. Solid matters are separated by filters of sand or of finely-powdered charcoal. The latter substance possesses the additional property of absorbing gases: hence its use in sweetening fetid waters. Carbonate of lime is decomposed by the mixture of muriate of ammonia in the water which contains it. This practice has been found efficacious in preventing deposits in steam-boilers. Gypsum may be thrown down in the form of carbonate of lime by adding carbonate of soda. A very ingenious process for the same purpose was exhibited:—by filtration through oxalate of baryta, sulphate of lime is entirely separated from its solution. This operation may still leave a trace of the oxalate of baryta in the purified water. This small contamination, however, may be entirely removed by making the fluid pass through a second filter of phosphate of lime. The water then becomes perfectly pure. With respect to the most dangerous of all impurities—the salts of lead—Mr. Solly showed that, unless common water contain (as we understood) from $\frac{1}{5000}$ to $\frac{1}{1000}$ of its weight of earthy salts—such as sulphate of lime—it ought never to be used as a beverage when kept in leaden cisterns. These earthy salts protect the lead from the action of the water.—Mr. Solly referred to the attempt to render lead insoluble by alloying it with $\frac{1}{100}$ of its weight of arsenic. He then spoke of the signal failure of an endeavour to protect lead from the action of water by placing it in contact with zinc. The result of this experiment was a vastly increased corrosion of the lead by the water in which it was immersed; which was, therefore, rendered additionally poisonous.

VULCANIZED INDIA-RUBBER.

At the Royal Institution, April 20, Mr. BROCKEDON explained "*The Preparation of India-rubber by Vulcanization and Conversion.*"—Mr. Brockedon's object in this communication was to describe—1. A mode of treating india-rubber by which new properties are imparted to this substance. 2. The new uses in the arts to which these acquired properties now render india-rubber applicable. *Vulcanization* and *conversion* denote that combination of india-rubber with sulphur from which the new properties about to be described result. The process of conversion consists in submitting india-rubber to the action of bisulphuet of carbon mixed with chloride of sulphur. The caoutchouc cannot, however, be penetrated by this process to any depth; and therefore it is inapplicable when the mass to be acted on is thick. The process of *vulcanization*, which seems to be more applicable, is the result of many experiments made by Mr. Hancock; who found that caoutchouc, when immersed in a bath of fused sulphur heated to various temperatures, by absorbing the sulphur, assumed a carbonized appearance, and lastly acquired the consistency of horn. It was in the course of these changes that it attained the state of vulcanization which Mr. Brockedon afterwards described. The same vulcanized condition can, however, be produced either by kneading the india-rubber with sulphur and then exposing it to a temperature of 190°, or by dissolving the india-rubber in any known solvent, as turpentine, previously charged with sulphur. Having thus explained the processes, Mr. Brockedon described the effect which they produced on the caoutchouc. 1. The india-rubber, thus treated, remains elastic at all temperatures. In its ordinary state it is quite rigid at a temperature of 40°. 2. Vulcanized caoutchouc is not affected by any known solvents, as bisulphuret of carbon, naphtha, or turpentine. 3. It not affected by heat short of the vulcanizing point. 4. It acquires extraordinary powers of resisting compression. Thus, a cannon ball was broken to pieces by being driven through a mass of vulcanized caoutchouc—the caoutchouc itself exhibiting no other trace of its passage than a scarcely perceptible rent. The applications of this substance appear

to be almost infinite. Our readers are familiar with the usefulness of the "elastic bands"—but they may not be aware that the same fabric, adjusted in size and strength to the purpose required, furnishes springs for locks and for the racks of window blinds. It is also capable of being moulded into the most intricate ornaments; its characteristic elasticity removing all embarrassment in relieving the undercut parts. It furnishes impervious bottles for volatile substances, like ether; as well as an excellent ink-stand. It is adapted to protect from corrosion wires subjected to the action of the sea, as in the case of the wires required for the projected electric communication between England and France. For the same reason, air tubes of vulcanized rubber are better suited for life-boats than those formerly made of canvas, which are liable to be destroyed by the action of the water. A similar tube has been used with success as a substitute for an iron band, as the tire of a carriage-wheel; and it is stated that a vehicle so arranged runs much easier than on the present plan. But perhaps the most important application is in its use in railroads and railroad carriages. In the former, it is laid between the rail and the sleeper, and thus prevents the rails from indicating any traces of pressure; and the springs connected with the buffers of the latter, when formed of vulcanized caoutchouc, can neither be broken nor can their elasticity be surmounted by any degree of concussive violence. In conclusion, Mr. Brockedon exhibited objects illustrative of the great physical change induced on caoutchouc by vulcanization. He showed a screw, with its recipient, both made of this substance, as well as a form of letter-press (like a stereotyped page) for printing. He also noticed its usefulness in making epithons for surgical purposes, gloves and boots for gouty persons, &c.

SCENERY AND DECORATIONS OF THEATRES.

Abstract of a lecture delivered at the Decorative Art Society, April 14, "*On the Scenery and Stage Decorations of Theatres*," by Mr. JOHN DWYER, V.P.

The author stated that the opinion which he had formerly expressed [see Journal, p. 23] on construction had, in the *Théâtre Historique*, recently opened in Paris, been in many respects exemplified. The criticisms upon this theatre state, that every person obtaining a seat is enabled to see the whole of the stage. With reference to the proscenium, he had become more forcibly impressed with the advantages arising from the form which he had then suggested; and he stated that Mr. Frederick Chatterton had since informed him that his instrument (the harp) was more favourably heard in Covent Garden than in any other of the metropolitan theatres. In an ornamental and artistic view, the form which he proposed combined some very essential properties. The proscenium, he considered, should form a frame to the animated picture on the stage; and the broad equal surface offered through his suggestion afforded an ample and suitable field on which to display rich and fanciful embellishments. The Surrey Theatre has an example of this framelike character,—and, together with the drop scene, exhibits thus far a satisfactory effect; and in the *Théâtre Historique* this has been attended to with success. The usual arrangements within the proscenium of crimson draperies frequently exhibit marvellous compositions—but of that commonplace nature which he would assist in exterminating. A drop-scene, he said, certainly required consummate skill. The pause in the excitement from the stage effects leads to the contemplation of the house in its *tout ensemble*—thus demanding a two-fold consideration; a subject of appropriate and interesting character, together with a proper regard to the general interior of the theatre. Mr. Dwyer noticed several devices which have been applied for drop-scenes, such as the looking-glass curtain at the Cobourg some years ago—which he termed a costly absurdity, although at that time thought "a great hit." But a drop scene painted by Stanfield for the opera of "Acis and Galatea," produced at Drury Lane some years ago, he pronounced to be a fine work. It displayed in vignettes ideal scenes by the artist from the opera; and thus offered to the mind's eye congenial Art during the pauses between the acts. Nevertheless, these pictures were placed within elaborate frames, contrasting strongly with the general expression of the theatre. A drop-scene painted by Mr. P. Phillips for Astley's was mentioned as a proper application of art to this purpose. It was intended to harmonise with the general business of the theatre, and was an excellent illustration of it, the subject being "Victoria's return from Olympian games with a procession to the sacrifice." The groups thus brought together had direct relation to the features in the performances on the stage. Mr. Dwyer considered that the composition always ought to have relation to the action on the stage; and observed that this principle has been regarded, in some degree, in the present drop-scene at Her Majesty's Theatre, where the design embodies abstract ideas of opera and ballet, but in connection with a massive architectural representation quite distinct from the general character of the interior, of which it occupies so large a proportion. He contended that more unity in this particular ought to be attempted; and stated that he would treat the drop-scene as a picture to which the proscenium should be an outer framework; but he would have, also, an inner frame, appearing on the scene, and partaking of the style of ornament adopted in other parts of the theatre. As approximating illustrations of his meaning, he mentioned those of the Princess's and the Adelphi, both of which, however, are defective in some minor qualities. This manner has also the advantage of contrasting with the stage scenery.

Mr. Dwyer next directed attention to light. He observed that the reflectors to the foot-lights in our theatres present an objectionable appearance; and he showed a sketch of ornamental screen-work for concealing them. He also suggested that they admit of a very different arrangement on the Bude principle with modifying reflectors; and that it would be advantageous to carry off the noxious result of combustion. He advocated the use of stronger side-lights, having their intensity regulated in accordance with the shadowing on scenery; and he mentioned, with approval, the effects thus occasionally produced in moonlight scenes. Mr. Dwyer then explained the management of colours for artificial light,—the exaggeration necessary,—the vigorous lights and shadows, and the broad and dashing touches which form the scene-painter's art. A slight knowledge of the stage, he observed, would be sufficient to prove that, at the present time, with one or two exceptions, the imitation of outward things is very imperfect. They are but half represented. The banqueting hall is resplendent with gold and silver, and gorgeous magnificence everywhere but on the floor;—and the forest luxuriant with foliage, and intricate with beauties in form and colour, is robbed of half its fair proportion of effect by the poverty on which it stands.

Mr. Dwyer stated that success had usually attended the careful "getting up" of plays; and that taste extended to the merest trifles had generally been appreciated by the public. A description was given of the arrangement of "wings, flats, and fly borders;" and the ludicrous *contretemps* of the scene-shifters in their working dresses appearing on the stage to remove refractory scenery, together with other casualties incidental to the change of scenes during the acts, were adduced as sufficient reasons for advocating a less frequent resort to that practice.

April 28.—Mr. DWYER read the second portion of a paper on the above subject, commencing with an examination of the advantages derivable from placing the scenery obliquely on the stage, referring of course to the wings and set scenes, the flats or back scenes being in the usual position. Some difficulties in perspective having been alluded to, it was stated that for drawing-rooms and apartments, the scenery ought to be arranged with due regard to the ground-plan of what is to be represented. This would enable actors to enter or take leave in a complete manner; they would not be observable by those in the side-boxes when approaching or lingering for that purpose, and their voices would reverberate and be carried into the body of the theatre. A scene in the "Flowers of the Forest," now being performed at the Adelphi, was described as an example, and also as clearly showing that with some attention to ground-plan in setting out an interior, together with an introduction of bay windows, octagonal recesses, &c., the variety and perfection of scenery would be greatly advanced.

Mr. Dwyer then directed attention to the principles of design, which he considered as mainly divisible into two classes, ideal and constructive; the former embodying certain characteristics without reference to natural laws, and the latter demanding strict attention to the fundamental principles of composition in art. Ideality, it was said, had in some extravaganzas been developed in a surprising and ingenious manner, and delicate conceptions in a refined taste were frequently introduced with that remarkable freedom peculiar to the School of Art.

Some chalk sketches, designed for the scenery to the "Enchanted Forest," lately performed at the Lyceum, were exhibited as illustrations of the vigorous manner and spirit of this class of compositions. Constructive design was described as necessary to architectural subjects. The opinions of Prof. Cockerell and others were quoted in acknowledgment of the artistic talent, together with accurate knowledge of the architecture of remote ages, which are frequently displayed in our theatres; and the reader suggested that if the attention of the students in decorative art at the Government School of Design were directed to the contemplation of the better scenic productions, having the beauty and principles of design explained, this would be found one of the most practical and efficient modes of acquiring knowledge.

He regretted that many admirable works of art, executed for theatres should have had such a transient existence, leaving scarcely a trace behind them. The creative fancy and design in numerous instances ought to have been preserved at any cost; and he argued that students in art would, in a careful contemplation of scenery, realise more freshness and originality in ideal and constructive design than from any other class of examples. Knowing its power and vast unexplored range, he felt an earnest desire that scene painting should be fully and properly estimated. Engraved examples might offer an interesting collection of the most ingenious fancies of the most eminent artists.

Perspective, the reader observed, constitutes one of the greatest obstacles to perfection in scenic effects, and he alluded to the defects which ordinarily appear in set-scenes, from their being made up of various parts, placed at intervals along the stage, each part drawn, probably, at a different perspective angle. The peculiar manner of treating perspective for theatrical purposes was explained. While the situation of spectators varies greatly, the treatment must necessarily be imperfect. It is, therefore, usual to set out scenery with two points of sight, but he preferred, in architectural subjects, to have *three*, and to have them placed near the centre, so as to counteract the effect of opposition in the horizontal features of the wings, whereby the scenes are frequently made to appear hoisted. Scenes showing ground in perspective, are frequently spoiled by the visible junction of the wings and the floor, thus disturbing the illusion of distance attempted by the artist; and he would tint the lower portion of the scene with colour similar to that of the stage. Architectural drop-scenes were

frequently objectionable from the same cause, and he maintained that they should never be thus applied, but only as pictures within frames, if applied at all.

The effect of linear and aerial perspective was adverted to, and the softening influences of colour in aerial perspective were described as pertaining to the highest order of artistic talent. Scenes of this kind are composed of a number of parts, the flats representing sky and extreme distance, while the middle distance and foreground are broken into perspective forms. Float-lights being placed behind these parts, impart brilliant effects that no colouring can attain to, resembling the sunny spots of a landscape.

Linear perspective required, it was said, very great consideration, and failures in street architecture, and similar subjects, are often evident to the least initiated observer. The artist, however, has to contend with serious disadvantages from not being permitted to set out this class of scenes upon the stage instead of in the painting-room; and the manner in which they are produced ought to be borne in mind when judging of their merits. Street architecture offers a peculiar difficulty from the actors influencing the scale by their comparative size; this illustrates the great absurdity of placing a façade of the National Gallery or other well-known building within the area of a theatrical scene, without a proper regard to distance. As an instance of a favourable effect, he named a scene in the "School for Scheming," at the Haymarket, representing portions of streets abutting on the quay at Boulogne, which he considered far removed from a commonplace effect, and that it also testified what might be obtained by placing scenery obliquely

Mr. Dwyer next alluded to the taste and refinement Madame Vestris had first presented to the public in her drawing-room scenes, elegantly and completely furnished; and he also mentioned with commendation some interiors produced at the Haymarket, in a similar spirit. He admired this perfect kind of representation, and was pleased with the manner in which it had been extended to exteriors, garden scenes, &c., and he referred to the garden scene in the "Lady of Lyons," at Sadler's Wells, in which the stage is covered with a painted cloth imitative of gravel walks, grass plots, shrubberies, &c., producing together a very superior effect. In a snow scene in the "Battle of Life," at the Lyceum, the stage was covered with painted canvas very successfully, and in the "Flowers of the Forest," the scene of a village church, with well-worn paths, &c., similarly treated, was equally skilful and pleasing.

Mr. Dwyer commented upon the fits and starts usual to these matters, stating that the better scenes were exceptions, while the imperfect school retained the predominance. As one of the earliest and most perfect illusions ever depicted, he described a scene introduced in the opera of "Acis and Galatea." The last scene in the ballet of "Coralia," at her Majesty's Theatre, was also fully described, as an eminent example of scenic display.

The author then noticed the machinery pertaining to theatres, and recommended the use of painted canvas placed on rollers sufficiently lofty so as to dispense with the series of curved, scolloped, and straight fly borders, ordinarily representing sky, &c. He next reviewed the inconsistencies which occur in scenery and properties being of a different period in character and style to that of historical dramas, mentioning a scene in "Lucia de Lammermoor," at the Italian Opera House, Covent Garden. It represents a Norman interior furnished with one chair of modern French style, and a table of doubtful period, the story of the opera being in 1669. He contended that those adjuncts are important; and that if costume, manners, and customs are rendered faithfully, properties should receive equal attention. The progress in matters of costume from the time of Garrick was noticed, and the properties introduced by John Kemble, Planché, and others, were mentioned with encomiums. The increasing taste of actors, shown in careful dressing and wearing apparel with a bearing in accordance with the period represented, was also favourably commended, as displaying research and accurate study of their art. Mr. Dwyer drew attention to the force with which the varieties of colours in dresses may be developed, by having regard to the background and to the position of the actors. An acknowledgment was made of the elevated taste and artistic arrangements which Mr. Macready had frequently shown in groupings and tableaux, and he concluded with the expression of a desire to find a proper feeling more generally established between the artists, actors, and managers, so that the capabilities of combined talents might produce results at once gratifying, elevating, and promotive of the welfare of the arts.

INSTITUTION OF CIVIL ENGINEERS.

April 27.—Sir J. RENNIE, President, in the Chair.

"*On the laws of Isochronism of the Balance-spring as connected with the higher order of adjustments of Watches and Chronometers.*" By Mr. C. FRODSHAM.

The first portion of the paper gave an historical sketch of the horological inventions and writings of the artists of the eighteenth century; which appear to constitute the basis of all the knowledge possessed in the present day, and the principles of whose school were still followed in the construction of both watches and chronometers of the better sort. It was admitted that, by the aid of machinery, and the practical skill of the workmen, the separate pieces of clocks and watches are now produced in a high state of perfection; but it was contended, that horology, as a science, had declined since the days of Hooke; Bernouilli, Sully, Graham. Harrison, Camus, Mudge, Ellicot, the two Arnolds, Earnshaw, Le Roy, Berthoud, and others, whose splendid talents and scientific attainments were all devoted to the elevation of the art of constructing time-keepers. Among these Dr. Hooke appears to have been the first to bring the force of acute reasoning and pure mechanical genius to bear upon the practice of the art, and from his experiments upon the pendulum and the application of the balance-spring—which latter unquestionably laid the foundation of the chronometric art—it is evident that he partially raised the veil which concealed the laws of the isochronism of the spiral spring; as is demonstrated by his expression "*ut tensio sic vis*,"—and it is extraordinary that so plain a hint was not immediately seized on by the able men who succeeded him.—Arnold appears to have been the first who really practically comprehended the subject; and in the course of his researches he invented the cylindrical spring and compensation-balance, which formed the commencement of a new era in the science. The merit of the discovery of the isochronism in France was contested by Le Roy and Berthoud. Bernouilli noticed, in a paper read to the *Académie* in 1747, the fact of the loss of elastic force in balance-springs, from exposure to heat; and the experiments of Berthoud demonstrated that in passing from 32° to 92° Fahrenheit the loss per diem was 6 minutes 33 seconds.

The paper then considered generally the subject of the isochronism of the balance-spring, enunciating isochronism to be an inherent property of the balance-spring, depending entirely upon the ratio of the spring's tension following the proportion of the arcs of inflection: a balance-spring, therefore, having the progression required by the law of isochronism will preserve that property, whether it be applied to a balance making quick or slow vibrations. The elastic force of balance-springs was considered as a constant, because the action is by a number of consecutive impulses following each other in such rapid succession as to constitute an uninterrupted and continuous force. This is shown in considering the accelerated and retarded motion of the balance, when by following it through an entire arc of vibration, it will be seen that if the balance be moved over a given number of degrees, the spring will be wound into a certain tension, and has acquired a certain elastic force due to the angle over which it is inflected. This elastic force being then transferred to the balance, it will be exerted in overcoming its inertia; and at the expiration of the first period will have communicated a slight motion to it. During the next period, its state will be that of comparative and not absolute inertia (for it *decreases* as the motion *increases*), whence it follows that as the spring's force is exerted against a body in motion instead of at rest, it will necessarily accelerate progressively the motion the balance had previously acquired, until the spring arrives at the point of quiescence, where, having lost all its elasticity, it ceases further to urge the balance, and a new relation of power and resistance takes place. The spring's force being transferred to the balance, it assumes a new character, has acquired sufficient momentum to carry it through the second half of the vibration, and to inflect the spring over an angle equal to that first passed over, and to give it the requisite tension to commence a new vibration,—particularly as during the second half of the vibration the spring has so little tension that its force retards but slightly the motion of the balance. After much acute reasoning upon this position, illustrated by numerical examples, the author proceeded to describe the helical and the flat-coiled springs which are used in chronometers and watches, and the manner of regulating their action, so as to take advantage of the isochronism, instancing the advantages to be derived from the innate power possessed by an isochronal-spring of resisting the influences which cause a change of rate—such as change of position, increased friction from dirt, or the viscidity of the oil at low temperature. This was illustrated by an example of three balls falling in equal times through spaces regulated by the densities of the medium, viz., in vacuo, in air, and in water, wherein they traverse spaces equal to the squares of the times.—So, it was argued, it was with increased friction in watch-work; for the elastic forces of the balance-spring being constantly proportional to the angle of inflection, whatever was the amount of friction, the law of isochronism remained unchanged; and friction was only an adventitious circumstance, which affects the extent of the arc of vibration, but not the time of its description.

May 4.—The discussion upon the above paper was continued. The viscidity of the oil, from its nature and from external causes, and the bad effects arising from it, were dwelt upon at great length; but, it did not appear, that either chemistry, or the practical experience of working watch-makers, had as yet either pointed out the true causes of viscidity, or enabled its effects to be satisfactorily remedied. The relative values of various modes of trial of timekeepers were also dilated upon. It was attempted to be shown, but was successfully refuted, that a taper spring would produce the same effect as the isochronal arrangement, and that the tapering could be effected by machinery. Among the external influences affecting the oil in time-keepers, was mentioned the circumstance of the watches belonging to George III., which, being kept in drawer of cedar wood, soon stopped, and it was found that the oil had changed into a substance resembling gum. Attempts had been made to substitute oil of sweet almonds for olive oil, on the recommendation of a distinguished chemist, but they were signal failures. The inefficiency of the remontoir movement was clearly shown, although its in-

genuity was fully admitted. Throughout the discussion the great merit of Arnold's improvements seemed to be recognised, and it was generally deplored that a spirit of epiricism has been allowed to stop the progress of so beautiful a science as that of the construction of time-keepers. It was, however, to be hoped that, by the facility afforded by the Institution of Civil Engineers of making known ingenious and recognised improvements, more particular accounts of what was done would be given to the world, and the merits of the scientific constructors of that indispensible instrument, the chronometer, would become generally known.

May 11.—The paper read was "*An Account of the Progressive Improvements in Sunderland Harbour and the River Wear*," by Mr. J. MURRAY.

The memoir commenced with an account of the coal trade, licenses having been granted by King Henry III., in 1239, "to the good men of Newcastle, to dig coals and stones in the common soil of the town and outside the walls." In 1384 permission was given to export the produce of the mines. During the civil wars, in 1644, the export from Sunderland was greatly increased, as no coals were permitted to be brought from Newcastle to London, on account of that town being a stronghold of the royalist party. Between 1704 and 1711, the average annual export had reached 174,264 tons; and that of the last year, 1846, was 1,500,000 tons. The census, in 1802, gave 19,100 inhabitants, whilst the town at present contains upwards of 60,000 persons.

The management and improvement of the River Wear was naturally an object of great solicitude, as its entrance was much exposed. In 1669 Charles II. granted a patent to E. Andrews, to build a pier, and erect light-houses, and forbade the casting of ballast, &c., into the river. An act was obtained in 1717, appointing river commissioners for the conservancy of the harbour, &c., giving power to raise money by tonnage duty on ships entering the port. The jurisdiction of the commissioners is limited by the last acts to an extent of about 11 miles, between Biddock Ford, above the town, and to a distance out to sea of a depth of five fathoms at low water. Little was done to improve the river until 1719; at that time the entrance was very intricate, and the two main channels were both very shallow. The south pier was commenced in 1723, for the purpose of directing the full force of the current against the bar. Busleigh and Thompson's map, published in 1737, shows the bad state at that period. Labelye (the engineer of Westminster-bridge) was called upon for his advice in 1748. He pointed out the principal causes of the then state of the river, and suggested the contraction of the channel at the worst places, so as to increase the scouring power of the stream, deepening the Still by manual labour, and by dredging engines, and constructing a north pier, so as to leave a distance of 200 yards between the point of that and the south pier. He stated, however, that "after all, as no man could foresee the consequences of erecting the north pier, if it caused a greater obstruction than it removed, it must be unbuilt and taken up." He recommended also throwing all the force of the stream into one channel, and cutting away the bar by ballast engines, and cautioned the commissioners against ever permitting sluices or locks to be placed upon their river.

Mr. Vincent, of Scarborough, was appointed engineer to the trust in 1752. Mr. Robin succeeded him in 1755, and under them the south channel was so much improved that the north channel was warped up with sand. Mr. Smith, of Sheffield, proposed sundry further improvements in 1758. Mr. Wooler also reported in 1767 on Mr. Robin's plan of building moles on the north and south rocks. The work was commenced, and was abandoned for reasons which do not appear. Mr. R. Shout was appointed in 1779; and in 1780, Mr. Smeaton's advice was sought. He recommended the prolongation of the piers on Mr. Shout's plans. The consequence of this constant extension of the south pier seems to have been the warping up of sand into the harbour's mouth. Two timber jetties were, therefore, suggested by Mr. Shout in 1786, and were the origin of the present north pier. The effects produced were very beneficial, as in a few months a deep and spacious channel was formed by the rush of the waters. The timber work was then cased with stone, and the work was continued by Mr. Pickernell, who succeeded Mr. Shout in 1795. He also erected the light-house at the point of the pier. The south pier was also extended. Mr. R. Dodd also reported on the works, and recommended chiefly the formation of a wet dock on the present Potato Gurth. Mr. M. Shout became the engineer in 1804, and he reduced some of the old works, whilst he extended the north pier. Mr. Jessop made a report in 1807, recommending further extension of the south pier, the reduction of the width of the entrance to 300 feet, and the construction of some embankment walls at various points to increase the velocity of the stream, and at the same time form a scouring basin. Mr. Giles made a survey under the directions of Mr. Rennie, which was completed in 1823, under Sir J. Rennie. This plan is published, and was exhibited. In 1824, Mr. Rennie recommended certain lines of extension of the pier, and the reconstruction of some parts of the works, with sounder materials, with other precautionary measures calculated to improve the port, some of which were carried into effect by Mr. Milton. Mr. J. Murray succeeded Mr. Milton, and carried on the designs of Mr. Rennie and Sir J. Rennie, with great solidity, using the diving-bell for part of the foundations. The north pier was thus extended to a total length of 1770 feet. He also removed, in an entire mass, the light-house to the extremity of the intended pier, an account of which has been already submitted to the Institution. In 1843, the south pier being in a ruinous state, was partially removed and rebuilt, in a direction better calculated to break the swell of the sea. The plans exhibited the changes that had taken place in the estuary, improving the channel, and giving, at least, 4 feet of water over the bar at low water of spring tides. It is narrow and shelving, with deep water on each side. Formerly the large ships took in part of their cargoes beyond the bar, but now they all load within it, even when drawing 15 to 18 feet, and as many as a hundred ships have entered and departed from the harbour in one tide. A longitudinal section of the river showed some remarkable changes in the bed, and corresponding improvements in the heights of the tide, affording, at the same time, increased facility for the drainage of the country around. Dredging has been carried on to a great extent, and from 100,000 to 150,000 tons have been raised annually.

The want of floating docks has been much felt, and several plans have been projected for them by Messrs. Dodd, Jessop, Stevenson (of Edinburgh), Giles, Brunel, G. Rennie, Walker, and G. Murray, but none have yet been executed. A small dock, of about six acres in extent, was finished in 1838. A south dock, with tide basins, is now in course of construction, under the direction of Mr. R. Stephenson and Mr. Murray, and by its means it is anticipated that Sunderland will become the first port, as to depth of water at its entrance, between the Humber and the Frith of Forth.

May 18.—"*An Account of the Sarah Sands, and other Iron Vessels, with direct-acting Auxiliary-engines, and Screw-propellers*," by J. GRANTHAM, of Liverpool.

The object of the paper was to show, that a propeller might be constructed of such dimensions that the number of revolutions it would require to make in order to obtain a high velocity would not much exceed that of the ordinary paddle-wheel, and that hence the usual marine condensing engine might be applied direct to the propeller-shaft, without the intervention of a secondary motion. It appeared from the statements in the paper that this opinion was found to be correct, and that Woodcroft's expanding pitch screw-propeller was the best form that had hitherto been employed. In a paper read to the Institution, upwards of three years since, Mr. Grantham gave his views on this subject, and several vessels had been since built—the results of the trials of which were communicated to the meeting. The principal of these were the *Emerald* and *Diamond*, three-masted steamers, of 300 tons, and 60-horse power; the *Nautilus*, of the same dimensions; the *Antelope*, of 600 tons, and 100-horse power; and the *Sarah Sands*, of 1000 tons, and 180-horse power. Drawings of these vessels were exhibited to the meeting. The capabilities and performance of these vessels were described in the paper, but particular notice was taken of the last-named vessel, which had performed a most successful voyage to New York during bad weather and adverse winds. The passages made by the ordinary New York liners, which were out at the same time, were very long, averaging 48 days each, and the Boston and Liverpool steamers were much longer than usual on their passage. The *Sarah Sands* used her steam about 17 days, and sailed the remainder, making her voyage in 20 days 10 hours. On her arrival she had about enough fuel remaining for four days' steaming. The paper did not enter minutely into the particulars of the screw itself, as it was considered that too much attention had been given to that branch of the subject to the exclusion of the consideration of the plans for working it, which, after all, had been the stumbling-block to the general adoption of the system. It was necessary with the screw, the theory of which, as a propeller, was so little understood, to proceed with experiments perseveringly in one direction, as variations in the results were frequently attributed to causes which really did not exist. After describing several interesting details, the paper concluded by expressing a desire that engineers should examine the drawings of the system laid before the meeting, and endeavour to add to the stock of information already obtained.

After the paper was read, Mr. Grantham added some facts which he had recently gathered, and which strongly confirmed what had been stated. The *Diamond* had recently made a very rapid passage to Madeira, deeply laden; but, during the whole passage, the engines maintained a very moderate speed, and quite removed the impression that under such circumstances they would run too fast from their being connected directly to the screw.

An account of the last successful voyage outwards of the *Sarah Sands* was also given, and it appeared that, in spite of most severe gales, which had driven back almost all other vessels, her passage had been made in the most satisfactory manner. In the discussion which followed, several engineers of eminence expressed themselves much pleased with the facts brought forward in the paper, and perfectly concurred with the views put forth. The principle of the following current of the ship, which had a material influence in increasing the efficiency of the screw, was alluded to, and a conviction was expressed that the screw would eventually supersede all other means of propelling vessels on long voyages.

An account was given also of the auxiliary screw-steamers that ply between London and Rotterdam, and some interesting facts were given of the power which these vessels possessed of working to windward in bad weather. The subject was closed by a discussion upon several points that had been started, relative to the size of the screw, the mode of disengaging it, and the prospects which were held out of the final success of the principle.

INSTITUTION OF MECHANICAL ENGINEERS AT BIRMINGHAM.

On Wednesday, April 28, a numerous meeting of the members and friends of the above Institution was held at the Queen's Hotel, Birmingham, for the general transaction of business, and the reception of scientific communications from the members.

In the absence of George Stephenson, Esq., President, Mr. M'Connell was called to the chair, and the minutes of the last meeting having been read by the Secretary (Mr. Archibald Slate),

The Chairman rose and said, the present meeting was one of the four ordinary meetings provided by the rules of the Institution, and required to be held on the fourth Wednesday in April. Since the last meeting, the Council had met on several occasions, and after discussing various subjects of interest to the Institution, they invited the London and Manchester branches of the body to meet them, consider their proceedings, and confirm them if approved of. The gentlemen from Manchester accordingly attended a meeting of the Council, on the 21st April, confirmed the past minutes of Council, and suggested some further improvements in the management of the Institution. The business of the present meeting was to confirm the minutes of the last general meeting, to receive new members and communications, and consult as to future operations; and here, perhaps, before they proceeded further, he might be allowed to say he had a very agreeable piece of intelligence to communicate, which he was sure would be very gratefully received by the meeting. It was the announcement of a handsome donation of 100*l.* to the Institution, by their worthy and highly-esteemed President, to whom he begged leave to propose a vote of thanks for this additional mark of his estimation of the Institution, which was unanimously assented to.

The Chairman stated that the Council was of opinion that the members ought at once to proceed to work and supply information on useful subjects; and, in order make a commencement, they had forwarded the following suggestions to each member of the institution:—

"1. The best form of railway axles and wheels.
"2. The best description of engine and mill for manufacturing iron.
"3. The best form of barker mill or turbine.
"4. The best form of luggage-engine for narrow gauge.
"5. The most economical stationary steam-engine, with coal at 6s., 12s., and 24s. per ton, taken in a commercial point of view.
"6. The best form of air-pump valves.
"7. The best high-pressure marine boiler.
"8. The best description of pumping engine for the thick coal district of Staffordshire.
"9. The flow of water through straight mains and curves."

The following papers were then read:—

1. "*Apparatus to be applied to Railway Carriages for lessening the dangerous effects of Collisions on Railways.*" By Mr. E. CHESSHIRE.

This method has been described in the Journal for September last, p. 285, it simply consists in applying beneath all the length of the body of each passenger and other carriage of every train an inflexible unyielding rod, which is termed a "safety-buffer," of wrought iron, and a tube plugged with wood, supported in suitable bearing-sockets beneath the framework of the carriage, at the middle of the breadth thereof, and left loose in those sockets. The safety-buffer terminates at each end with an enlarged head like those of ordinary buffers, and the heads of the safety-buffer of each carriage correspond to the like heads of the safety-buffer of the preceding and following carriages. When the usual coupling links are screwed up to bring the ordinary buffer heads of the several carriages into elastic contact one with another, as is usual, there will be a vacant space between the safety-buffer head of each carriage and that of the next adjacent carriage, varying from three to six inches, more or less, according to circumstances, and the safety-buffers will not have any effect or operation in the ordinary course of travelling, but only in case of a collision. The safety-buffers in the van, at the hinder end of the train, and in the tender at the front end, are not to extend throughout the whole length of those carriages, and need not have any end-way motion, but may be firmly fastened to the framework of those carriages, or they may be applied against strong elliptical springs, placed end to end for expending some of the force of the collision. The van is to be lower than the passenger and other carriages, in order that its centre of gravity may be nearer to the level of the rails. The van at the hinder end of the train is to have its ordinary buffers with easy yielding springs, which, with the same force applied to them, will allow those buffers to move through a much greater space in respect to the van than the ordinary buffers of the carriages of the train, so that, in case of a collision from behind, the ordinary buffers of the van being so yielding, they will not act with much force against the corresponding buffers of the hindmost carriage of the train.

Remarks.—Mr. W. ROBINSON, of London, said, it might be advanced against the proposed improvement, that every rod being six inches less in length than the side buffer, would lose six inches in every carriage; consequently, supposing a train to be composed of, say 50 carriages, it would require 25 feet for the stroke of the last buffer. It might also be objected that the rod would double up; four or six inches in diameter was not sufficient to take the amount of force imparted by the collision. He would estimate that it would require 13 feet diameter to oppose the force of the shock imparted to it.

Mr. CHESSHIRE replied, that the momentum was communicated to the first rod, and through each individual rod to the last instantaneously, and through it to the hinder van, just as in the case of a number of billiard balls placed in a row. When the first was struck, the last was driven away with all the impetus communicated to the first, leaving the intermediate balls perfectly at rest.

A Member suggested that it would require 300 tons to double up a rod four inches in diameter.

MR. CHESSHIRE—I take it at that calculation, and say, consequently, supposing the momentum of the collision to be greater than that, it was quite evident that 300 tons must be taken from the amount of collision imparted to the train and expended upon the van behind the train. As the stroke of the side buffer was 13 inches, it was quite clear six inches might be allowed for the stroke of the centre buffer without any injury to the passenger carriage; consequently, if 25 feet were lost in the centre buffer in a train of 50 carriages, 54 feet would be gained by the stroke of the side buffer, leaving a surplus of 29 feet.

2. "*Disconnecting Coupling.*"—Mr. JOHNSON, locomotive superintendent of the Manchester and Leeds Railway, produced a model of an invention for disconnecting the carriages from the engine, in the event of an obstruction on the line, or any other accident which would cause the engine to run off the rails, by a self-acting disconnecting coupling chain, which he proposed to apply between the tender and the luggage van. It was exceedingly simple and inexpensive, and might be applied to any train with a slight alteration of the present coupling crook of the luggage van or carriages. In case the engine or tender got off the rails from any cause whatever, regardless of the speed, the engine or tender would be immediately disengaged from the train, allowing the latter to remain on the line perfectly uninjured, and thereby accomplishing the object for which it was intended. He had had a working model twelve months, and during that time tried it repeatedly, and could now speak confidently of its merits.

Mr. MIDDLETON, having inspected the model, said he believed a patent had been taken out some years ago for a similar invention. He thought the plan a very good one; but he was under the impression that at the time Dr. Church's carriage was before the public, it was said that such an invention had been patented.

Mr. BEYER was also of opinion that the idea or principle of the invention was not new, as it had been proposed by Mr. Watson Buck, engineer, on the opening of the Manchester and Birmingham Railway.

Mr. RAMSBOTTOM, of the London and North-Western Railway, feared the violent oscillation of the carriages would produce the same result. He had seen carriages vibrate very much when not sufficiently tight.

3. "*Railway Axles.*"—Mr. H. BESSEMERE, manufacturer, London, produced a model of a railway axle, to do away with the necessity of covering the tire, which the inventor stated caused great tear and wear of the rails and tires, and also a tendency in the carriages to an oscillating or vibratory motion when running on a straight line. Mr. B. stated that the means by which he proposed to effect his object was by cutting the axle in two in the centre, and holding it rigid and in its place by a long coupling, with concentrated grooves, so that each wheel, and the end of the axle, could revolve independently of the other.

Mr. BEYER said an invention for accomplishing the same object had been proposed, and applied before, and in his opinion one more simple had been tried. He had seen the same idea carried out in two different ways. He questioned the desirableness of having such an invention at all.

4. "*Description of a new Railway Break,*" by Mr. F. KNIGHT, was read, which requires a drawing to make it understood.

May 18.—Mr. J. E. M'CONNELL, in the Chair.

"*On the use of the Fan-blast for manufacturing purposes.*" By Mr. BUCKLE, the following papers were read:—

1. This paper described a series of experiments on the fan-blast, as applied to manufacturing purposes. They were made for the purpose of guiding the construction of the fan, so that the greatest quantity of air could be accumulated with the least possible expenditure of power. The original application of the fan was for the purpose of separating and dressing seeds, the speed and density of the air being limited to manual power. But since their application to smitheries and foundries, steam and other motive power have been used, their speed so increased that the density of the air ranges from 3 oz. to 12 oz. per square inch. Various forms of fans have been made, but the one generally preferred is called an eccentric, with three or six blades or arms radiating from the centre. This indispensable machine is one that has abridged much time and labour; the uniform stream of air admits of no comparison with the puffing blasts of the bellows or cylinder. The smith can heat his work with precision, proportion the size of his nozzle tuyeres to suit his work, without deteriorating the intensity of the blast, and in some instances it enables him to heat one piece of work while shaping another, the pressure of the blast ranging from 4 oz. to 5 oz. per square inch, with nozzle tuyeres 1¼ inch diameter; but in a well regulated smithy, the nozzle is fitted with nose-pipes as ferrules, varying from 1 to 3 in. diameter, to suit the quantity of blast required. An eccentric fan 4 feet diameter, the blades of which are 10 inches wide by 14 inches long, and running 870 revolutions per minute, will supply air at a density of 4 oz. per square inch, to 40 tuyeres of 1¼ inch diameter each, without any falling

off in density. In the first six experiments no discharge of air takes place, the velocity of the fan merely keeping the air at a fixed density or pressure per square inch due to that velocity. The remaining 26 experiments show the fan discharging air. An inspection of the table will show that, under various conditions of velocity of the tips of the fan, that density of the air, and theoretical quantity of the air discharged, varies, but not in a direct ratio. The best results are obtained when the velocity of the tips of vanes coincide with the velocity, and 9-10ths of the velocity a body would acquire by falling freely the height of a homogenous column of air due to its density. This is what we have called the theoretical velocity; or, in other words, the greatest quantity of air is discharged by the fan with the least expenditure of power when the tips of the vanes move at these velocities.

In a recent set of experiments, the inlet openings in the sides of the fan-chest were contracted to 12 inches, and 6 inches diameter—the original diameter being 17½ inches. The results obtained were, that with the 12 inch openings, the power expended was 2½ to 1 compared to the openings of 17½ inches, the velocity of fan, the density of air, and the cubic discharge being the same. With the 6 inch opening the same results followed as with the 12 inch, only the density of air decreased one-quarter. These experiments show that the inlet openings must be of sufficient size, that the air may have a free and uninterrupted action in its passage to the blades; for if we at all impede this action, we do so at the expense of power. Here follows a copy of the tables of 32 experiments, after which the paper gives the dimensions of fan employed in these experiments—namely, 3 ft. 10⅞ in. diameter; width of the vane, 10¾ inches; and the length, 14 inches. The fan is eccentric 17-16th inches; the vanes are five in number, and are placed at an angle of 6° to the plane of the diameter. The inlet openings on the side of the fan-chest are 17½ inches diameter. The outlet opening or discharge passage is 12 inches wide and 12 inches deep; the space between the tips of the blades and the chest increasing from two-eighths of an inch on the exit pipe, to 3½ inches at the bottom, in a perpendicular line with the centre.

Mr. Buckle said, that he had found that the area of the discharge and the density of the air corresponded very nearly. His object had been to show the quantity of the air discharged at a certain density, and the power it required to effect that result.

2. Another paper on the same subject, from Mr. Jones, of the Bridgewater Foundy, Bridgewater, was also read.

Mr. Jones observes—"There is, perhaps, no point upon which mechanics have had a greater variety of opinion than that of the application of the fan for manufacturing and other purposes; nor is there any other subject which has caused more disappointment; and I am decidedly of opinion that this has been principally occasioned by constructing the air passages too small in the fans, as well as the passages leading to the tuyeres. Facts are always better than opinions; and in offering the following statement, I merely give the result of six months' constant work. Two points of importance in the construction of fans are, an exact balance of the fan upon the axle, and a careful and judicious arrangement for getting up the speed so as to avoid either tight straps, or any slipping up on the pulleys. With this I forward you a drawing of the fans I have constructed. You will perceive that I have the openings unusually large, but the results have fully justified the proportions. With these two fans we have been melting 50 to 60 tons of iron per day, at the rate of 5 to 6 tons per hour, with a consumption of coke of 208 lb. to the ton of iron; in addition to which there are upwards of 50 smiths' fires blown at the same time. The power required is about eight horses, the motion being taken from a 12 horse power engine by means of a 7-in. gutta percha belt, the shaft running at 73 revolutions per minute: the speed of the fan is about 750. They are driven by a pulley on each end of the spindle. This I think much better than a single strap. The openings at the side of the fans are 2 ft. 4 in. in diameter, and the outlets are 24 inches by 12 inches. The passage from the fan is 2′ 9″ by 1′ 9″, leading to a reservoir under the cupola 18′ 0″ by 7′ 0″ by 4′ 0″ deep, from which we have two tuyeres 6 inches in diameter. The pressure of blast is about 5½ oz. per inch. The only thing to which I wish to call your attention is the increased size of the air passages; and when we consider the large quantity of iron melted, and the small proportion of coke used, the result is very satisfactory."

Mr. Buckle remarked, that his paper had been drawn up for the purpose of recording a course of experiments made during a series of years at his leisure, and which had been executed with the utmost care. The results were important to those who were about to adopt the fan, as teaching them that its size must not be a matter of guess-work. When he himself had a fan made, all the advice he could obtain was, "Make it big enough." The parties who said so knew nothing about it. Had he been then in possession of the results of his subsequent experiments, he should have had his fan made only half its present size. He now found that all required was, that the tips of the fan should revolve with 9-10ths of the theoretical velocity. In driving the fan at that speed they would obtain the largest portion of blast at the least expenditure of power. By driving them at a greater velocity, the power was absorbed without producing a greater quantity of blast.

Mr. Cowper wished to know if the horse-power mentioned by Mr. Jones was indicated or commercial horse-power? Was it the same as that meant by Mr. Buckle?—Mr. Buckle said, he had ascertained the power by a dynanometer, having a spiral spring and a piston attached. Having ascertained the amount indicated by the engine when disconnected with the fan, he had deducted that amount from the amount shown in every experiment. The engine was nominally a 14-horse power engine. He had found that by a succession of fans, the first transmitting the blast to the second, and so on, he obtained by the third or fourth a pressure of 2½ lbs. on the square inch.

Alderman Geach remarked, that this plan was in use at a furnace fitted up some three or four months since in Derbyshire, where they proved that they could obtain a pressure of 2½ lbs. on the square inch, and that they could make better iron, and in a larger quantity, than by the old plan.—Mr. Buckle had not been previously aware that the plan had been tried, but he had ascertained that uniformity of the discharge was greater than that of the blowing cylinder, and the quality of the iron would be better.

Mr. Henderson said, that in the works in Scotland with which he was connected, they had a fan so badly constructed that they were about to have it altered, which, nevertheless, turned out 220 to 230 tons of casting per week. They had found that they could get something like double indicated power out of the ordinary Fairbairn's engine, compared with what it was sold for. He should like to know the proper form of the fan, the proper length of pipe, and the size of the pipe which conducted the blast from the fan to the place where they wished to use it. In Scotland they were working a shaft 200 feet long; and he should like to know whether they could effect their object by laying down underground piping, instead of having a shaft to conduct the power to near the place where they wished to use it. They had enlarged the tuyere pipe, having ascertained that, in melting iron, the density of the air was not so important as the quantity, and that it was necessary that the air should be admitted in large quantities.—Alderman Geach knew of one furnace where the cupola was 150 feet from the blast.—Mr. H. Smith stated some experiments, which went to show, as the Chairman remarked, that, putting the case in an extreme point of view, the further the blast was from the fire the better. The discussion was then adjourned, to afford an opportunity for further experiments.

3. "*Heated Air.*" The next paper was from Mr. Wilkinson, who, the Chairman observed, had been so bold as to try a totally new plan for economising fuel, by introducing *heated air into the boiler of a steam-engine*, among the steam, by which the inventor estimated that he effected a saving of 20 to 25 per cent. in fuel. They had had steam and heated air separately, but this was the first attempt to combine them. The following are extracts from the paper:—

"It is an unalterable law of Nature that to produce a given quantity of steam, a given quantity of heat must be imparted to the water, and that in proportion to the steam required. Therefore, under the most advantageous circumstances, to produce an effect, a certain amount of combustion must necessarily be expended. Now I find, from repeated experiments, that water alone is not the most economic agent to work with; and, by way of elucidating this fact, I will explain one, and only one, though not the most successful of my experiments, and this was made on a six-horse power high-pressure engine, working in the manufactory of Mr. J. Burman, Cumberland-street, Curtain-road, London. The principle consists in the injection of a stream of air, heated to the high temperature of 800, into the steam in the boiler—by which means the temperature, and consequently, the expansive force of the steam, was increased. To effect this object, an iron pipe or tube was bent in a serpentine form, so as to present a great extent of surface, and placed under the boiler, there to receive a red heat from the glowing part of the fire, after it had passed the bridge on its course to the flue. One end of this rarefying chamber was connected with an injecting air-pump, proportioned to the size of the cylinder of the engine. The other end was inserted by a continuation of the tube above the surface of the water into the steam in the boiler. The whole capacity of the tube was greater than the volume of compressed air which it received from each stroke of the piston of the pump, so that the air did not enter the boiler until it had acquired the full heat or nearly so of the red-hot tube through which it passed. At every stroke of the piston the same quantity of cold air was injected into the tube. That part of the air which was next to the pump was forced into a hotter place, and the air, which previously occupied that hotter place, was forced on to a still hotter one, and so on, until the furthermost and hottest of all was discharged into the steam in the boiler. The pressure of air in the tube, strictly speaking, exceeded that of the steam in the boiler, for it was an excessive pressure that overcame the resistance in the boiler. That, at the commencement of each stroke the air in the cylinder of the pump was in equilibrium with the external air, and only opposed a resistance as it became compressed, and gradually increased its compressed force until it arrived at its maximum, which was the point of equilibrium with the compressed air in the hot tube and the resistance of the steam. Taking all things into account, the whole amount of power expended in working the pump was about 5 per cent., or 120th of the force which acted on the steam cylinder of the engine, and the result of the experiment showed that the application of the heated air caused a reduction in the quantity of coal consumed of from 25 to 30 per cent., and this was continued for several weeks, the engine of course working at its usual pressure."

The Chairman had had his attention called to the subject by Mr. R. Stephenson, who wished him to try it in the locomotives on the line, but he had preferred to wait till he had ascertained whether the principle was economical, and whether the results could be depended on with a stationary engine.—Mr. Cowper had seen the invention tried, and observed that the engine worked slower with than without it; but, as the inventor con-

sidered the engine out of order, he would not express any opinion upon the value of the invention.

ROYAL INSTITUTE OF BRITISH ARCHITECTS.

May 17.—Earl de GREY, President, in the Chair.

The President presented to J. W. Papworth, Fellow, the Medal of the Institute for his Essay "On the Adaptation and Modification of the Orders of the Greeks by the Romans and Moderns;" and to James Bell, the Medal of Merit for his Essay on the same subject.

The Rev. Prof. WILLIS read a paper "*On the Successive Construction and History of the Church of the Holy Sepulchre at Jerusalem, from Constantine downwards.*" After alluding generally to the holy places visited by the pilgrims and grouped together within the walls of the church, and the buildings immediately connected with it, he then proceeded to give a brief history of the church. Constantine raised structures to preserve the memory of three spots,—the birth-place of the Saviour, the scene of the resurrection, and that of the ascension. The second, or church in question, remained till the invasion of the Persians in 614, when it was destroyed. It was re-erected by Modestus, soon after, but was much injured, though not destroyed, in 637, by the Mohammedans. The crusaders made considerable additions to it, and so it continued till 1808, when it was burnt down, and afterward rebuilt in such a manner as to disguise its real character.

The problem was, to discover what Constantine's architects did; and to obtain knowledge of this it was necessary to go to documentary evidence. The writings of the pilgrims, one as early as 333, were of the utmost importance, and had been carefully examined by him. A minute plan of the present church, made by Mr. Scoles, he had found of great service. First describing the church as left by the crusaders, he said he considered the tomb not to be a built structure, as often supposed, but a genuine rock sepulchre, pared down and decorated externally; and he showed the probability of this, by tracing the line of portions of the rock yet remaining at the west end of the circular building. About this the round church was built in the late Greek style, like the church of St. Sophia, and others. The appendage towards the east, added by the crusaders, was Romanesque, resembling many early buildings in Europe, and similar to those we call Norman. It had a semi-circular apse at the east end, with an aisle round it, and radiating chapels.

The original building, according to the professor's views, consisted of an enclosure of columns, with an apsidal termination towards the west (affording the foundation for half the circular building afterwards erected), having at the opposite extremity a basilica, similar in plan to those of St. Peter and St. Paul. To learn what the crusaders added and altered, it was only necessary to look to William of Tyre, who is very clear, and shows how the round church and court towards the east, with other sacred spots, such as the site where the wood of the cross was discovered, were converted by them into a mediæval church of their own fashion. In doing this they exhibited much cleverness. It should be remembered, he said, that the Knights Hospitallers had the custody of the sepulchre, not the Templars; the latter had charge of the site of Solomon's Temple.

For an account of the church raised by Constantine, he of course went to Eusebius, and gave a translation of some passages in that author, who was more an encomiast than an architectural critic, and must, therefore, be listened to sceptically. When Constantine proposed to commence a house of prayer on this site, he found there a Temple of Venus; and on pulling this down, discovered the cave. Eusebius says, that the walls of the basilica were coated with marbles, the roof covered with lead, and the inner ceiling gilded. He describes a propyleum to the east; and the lecturer said a Roman gate had recently been discovered there, which he had little doubt was the very propyleum so referred to. In this basilica the apse was at the west end,—it was not till afterwards that the altar was placed at the east end of sacred buildings. The cave then stood in the open air, surrounded by porticoes, as we have already said; and a passage in a sermon by St. Cyril, preached in this church, bears out this opinion. The professor concluded by soliciting information from any who might visit the spot.

May 3.—W. TITE, Esq., V.P., in the Chair.

The annual general meeting of the Institute was held this evening, to receive the report of the Council on the state of the property and affairs of the Institute, and to elect officers for the ensuing year.

The report showed that the finances were in a very satisfactory condition. Relative to Mr. Weale's proposal to publish annually a volume illustrative of the works of the members, the Council stated, that, as the plan required them to guarantee a supply of matter for the volume by the members, which they had not power to compel, it was necessarily declined.

The Chairman alluded to the difficulty with which becoming papers for the evening were obtained by the secretaries, and called on the members to afford them that assistance which they ought to expect.

The following gentlemen were elected Officers for the ensuing year: *President*, Earl de Grey; *Vice-presidents*, Messrs. S. Angell, A. Poynter, and C. Fowler; *Council*, Messrs. G. Alexander, H. Ashton, C. Barry, D. Brandon, R. D. Chantrell, T. L. Donaldson, J. B. Gardiner, E. I'Anson, G. Pownall, and John Woolley; *hon secs.* Messrs. Bailey and Scholes; *foreign sec.*, Mr. Donaldson.

ROYAL SCOTTISH SOCIETY OF ARTS.

April 26.—GEORGE TAIT, Esq. V.P., in the Chair.

The following communications were made:—

1. Description of "*a Night Telegraph by Coloured Lights,*" to be used on Railways, Ferries, and in Military operations, &c. By J. STEWART HEPBURN, Esq.

This telegraph consists in the employment of various combinations of the only two colours, *red* and *white*, which are distinctly visible at considerable distances. This is effected by the use of a lamp, inclosed in a hexagonal screen, which revolves horizontally on pivots; four of the compartments being opaque, and two furnished with lenses, one red, the other colourless. By the turning of the screen the light can either be masked or shown of a red or white colour as the particular combination may require. Three such lamps are hung on pivots on an arm or beam 15 or 20 feet in length, turning vertically on its centre on an upright post, and made to assume four definite positions, horizontal, vertical, and diagonal, rising from the left or falling from the left. The different positions of this arm, together with the varieties in *colour* and *order* given to the lights by this construction of the lamps, afford at least fifty distinct combinations, to which numbers, or the letters of the alphabet, and arbitrary significations adapted to the particular uses of the telegraph, may be assigned.

2. Description of "*a new method of overcoming an Incline of* 1 *foot in* 12, *with a new Locomotive Reversing Steam Engine.*" By Mr. DANIEL ERSKINE.

In addition to the small wheels keyed on the axle outside of the usual large wheels of locomotives, and connected by connecting rods, Mr. Erskine has a toothed pinion on each side of the engine, dropping down betwixt the flange of the small wheels and the large wheels, which, on the locomotive coming to a steep incline, say 1 foot in 12, works into strong pins or bolts, fixed on the inside of the raised rail. The engine and carriages all the while running on the small wheels, by which their whole weight is borne, and the large wheels acting as fly-wheels, leaving the toothed pinions nothing to do but to work in gear with the pins or bolts, thereby effectually preventing slipping. It was shown, by a beautiful working locomotive of about 9 lb. weight, made by Mr. Erskine, and fitted with his reversing pivot valve, that by this means it easily ascended an incline of 1 foot in 10; and on an incline of 1 in 16, the small wheels themselves, without the toothed pinion, easily accomplished the ascent; whereas the engine could not attempt the ascent with its ordinary larger wheels. It was stated that this is not the first time a rack and pinion has been proposed on the inclines of railways, but that it has never been proposed in the way now done by Mr. Erskine, by whose method the power is so vastly increased by being brought to act so near to the centre of the wheel.

3. Description of a proposed "*Plan for arresting the progress of Fire in Dwelling-Houses, Factories, and other Buildings, by means of Fire-Shields.*" By Mr. ALFRED CANNING, of London.

The invention consists in the adaptation of sheet-iron, copper, or other metallic cases, filled with water, and interposed between a fire and surrounding objects, in order not only to prevent such objects, however inflammable, from ignition, but also to shut out draughts of air from feeding a fire. For general purposes, Mr. Canning proposes the use, principally, of three modified forms of cases or shields, viz., Nos. 1, 2, and 3. No. 1, a sheet-iron, copper, or other metal, case or shutter, about 6 feet long, 3 feet wide, and 2 inches thick, open at one end, intended to be placed, with the open end upwards, against the door or window of a room on fire, or a succession of such shields might be set up against partitions inside of adjoining rooms, and then filled with water by buckets, &c., or by directing the nozzle of a fire-engine hose over the open ends of the shields. Such shields may be secured by proper means to doors and elevated windows of buildings opposite to and contiguous to a fire. Shields Nos. 2 and 3 are cases of similar dimensions to No. 1, but adapted either to protect firemen and engines in approaching a fire, or to be laid flat over the floors of rooms immediately above those on fire, to prevent the fire from communicating with the upper parts of a building.

SOCIETY OF ARTS, LONDON.

April 28.—W. H. BODKIN, M.P., V.P., in the Chair.

The following communications were read:—

1. By Mr. T. DRAYTON, "*On his patent process for Silvering Glass with Pure Silver.*"—"The table used by me (observes Mr. Drayton) in silvering is of a similar description to that ordinarily used, the glass to be silvered being fixed horizontally upon it by means of machinery. It is necessary that the piece of glass should be perfectly level, so that the liquor poured on shall act equally on all parts of the surface. The material used consists of nitrate of silver, to which is added ammonia, water, spirits of wine, and thirty or forty drops of oil of cassica; in this state, the liquor can be kept for a long time without deteriorating. When it is required for silvering, oil of cloves is to be added to it; and in proportion to the quantity of oil of cloves added, is the length of time required to perfect the deposit. The deposit takes place equally well whether the surface is

flat or of any other form; after it is silvered it is washed, to remove the impurities which have been deposited with the silver, and then placed in a hot-air closet, where it remains for a few hours until perfectly dry; it is then varnished, to protect it from the action of the air, and also from being scratched. Glasses of any dimensions may be silvered in the most perfect manner in 48 hours. The silver deposited by this process adheres more firmly than does that by the old method; it is also less injurious to the health of the workman, as mercury is not used; and the cost of production is not increased."

Mr. WINKWORTH stated that he considered the invention as one of the most beautiful and most valuable of the present day, as the silvering can be applied to any surface without difficulty.

Mr. NEWTON observed, that as it is a solution of silver that is used, there is no other method of obtaining such fine particles; the adhesion is firmer, the use of mercury is dispensed with, and the whole process is completed without increase of cost.

2. By Mr. BRETT, "*On his Electric Printing Telegraph.*" The apparatus was exhibited.—The author commenced by stating, that in July, 1845, he endeavoured to introduce to the government his printing telegraph, and to urge on them the importance of adopting some such plan as his, in the place of the semaphore. The great advantages of the electric printing telegraph, either for government or other purposes, are its great simplicity, certainty of action, and economy. The instrument consists of two parts; one having a row of ivory keys, with the letters of the alphabet, words, or other characters, marked upon them, and is connected with one end of the telegraphic wire, the other end being connected with the printing machine. The printing machine contains a type-wheel, having on its circumference corresponding letters, words, or signs with the key-board, and by means of weight movements and an escapement, a very slight power is sufficient to regulate the whole; so that the instant a key, representing any letter, &c., is pressed down, the corresponding letter, &c., is printed and a bell rung at the other end of the instrument.

Mr. Brett stated that he considered the advantages of his instrument to consist in its making a permanent register of the communication transmitted, it being printed on paper supplied from a roll of unlimited length, from which any portion of the correspondence may be cut off at pleasure.

3. By Mr. F. WHISHAW, "*On the application of Heated Currents to Manufacturing and other purposes.*"—"In November, 1844, (says Mr. WHISHAM) I read a paper on the manufacture of casks, more particularly those used by brewers, with remarks on the various methods adopted for cleansing and purifying such vessels. The object of the present paper is to show the advantages arising from the application of the same patent, viz., that of currents of heated air to the following purposes:—1. Seasoning timber generally. 2. Preserving timber. 3. Purifying feathers, blankets, clothing, &c. 4. Drying coffee. 5. Roasting coffee. 6. Japanning leather for table covers, and other purposes. 7. Drying silks. 8. Drying yarn. 9. Drying distillers' tuns. 10. Drying papier maché. 11. Drying vulcanized India rubber. The process has also been successfully tested for the following purposes:—12. Drying loaf sugar. 13. Drying printing paper, or setting the ink to enable books to be bound more quickly than usual. 14. Drying starch, and converting it into dextrine or British gum, and also, 15, for preserving meat." The paper then proceeded with a very lengthened account of the action of heated air on the various kinds of timber, and the success which had attended its adaptation for that purpose. It was also stated that sixty suits of clothes, which had belonged to persons who had died of the plague in Syria, had been subjected to the process of purification, at a temperature of about 240 degs., and afterwards worn by sixty persons, not one of whom ever gave the slightest symptoms of being affected by the malady. The author concluded by referring to the mode adopted by the North American Indians, for preserving the flesh of the buffalo, viz., that of drying it in the sun, and stated that heated currents had been applied successfully. "How important for shipping? Instead of sailors consuming salted provision from one month's end to another, to have an occasional supply of fresh meat." It is important also in other respects, as meat treated in this way occupies much less space, and is much lighter in weight. It is believed that the juices of the meat contain about ¾ths of watery moisture; this the current of heated air removes, and leaves the albumen, and all the flavour and nutrition behind.

May 5.—Sir JOHN BOILEAU, Bart., V.P., in the Chair.

1. By Mr. DEFRIES, "*On his new Patent* (3rd) *Dry Gas Meter.*"—It is notorious, observes Mr. Defries, that the gas supplied by some London and provincial companies, contains sulphuretted hydrogen and ammonia, and these tend to impair the gas meters and prevent correct registration. The object of the present invention has been to place the more delicate and working parts of the meter beyond the reach of the gas and its injurious action; and has been accomplished in the following manner—viz.: by shutting of the machinery in the upper chamber of the meter, by means of a rotary air-tight valve, which allows the gas to pass from the main to the meter, and from the meter to the supply pipe, without even coming in contact with the vital parts of the machine. The valve and gearage are also made of an amalgam of metal, upon which the ammonia and sulphur of the gas do not act. Gas meters on the old and new principles were exhibited, as well as numerous specimens of the metals, which had been rendered useless from the action of the impure gas.

Mr. NEWTON said, he did not consider Mr. Defries entitled to the merit of the invention of the rotary valve, as it had already been patented by Messrs. Edge and Wright.

Mr. WRIGHT was present, and exhibited one of his valves. He also stated that Mr. Defries' meter had still about twelve of the working parts exposed to the action of the gas.

Mr. DEFRIES, in reply, stated that he was quite aware that the rotary valve had been previously patented by Messrs. Edge and Wright; but there was this difference between his and theirs—viz., that theirs was a three-throat valve, and does not shut the gas off from any part of the works, while his is a six-throat valve, and excludes the gas from all the more delicate parts of the machine.

2. By Mr. T. BOCCIUS, "*On his improved Gas-burner.*"—The two most important points in the combustion of gas, are economy and perfect light; "and these desideratum combined, I believe I have attained," says Mr. Boccius, "with my burners." The patent for the present burner was taken out in 1843; and the burner is so constructed as to admit such an amount of atmospheric air as will completely oxygenate the burning hydro-carbon, at the same time keep up the same amount of intense heat, even to the apex of the flame, which is necessary to the incandescence of the solid carbon, in order to obtain luminosity.

"In the patent of 1843, (Mr. Boccius says) I did not confine myself to any given form of burner, as my apparatus can be adapted to all forms, whether flat, half-circular, triangular, circular, &c., the result always being the same."

It consists of a series of concentric rings, from the centre of which rises a crescent-formed tube, with other concentric rings. These latter serve to keep up the required heat at the apex of the flame, and also to steady the light. From the form of burner, it is shadowless, no portion of the light being obstructed either above or below the flame.

Mr. NEWTON and Mr. ROBERTS then alluded to the tulip-shaped burner, for which a patent had been taken out, that particular form being given to the flame by means of a current of air passing through a perforated button or inverted cone, into the body of the flame.

Mr. BOCCIUS stated that the inverted cone was included in his patent; that no action took place from the passage of air, as stated, the flame being expanded more or less, according to the height at which the cone is placed in or from the flame.

The Secretary described "*An Excavating Machine,*" by Mr. PRIDEAUX. (See Journal for July last, page 219.) The machine consists of a series of scoops attached to arms fixed on an axle driven by a steam-engine. As the scoops revolve, they slice off the earth, and discharge it on to an inclined plane, on which it is removed to the wagon. The whole apparatus bears a resemblance to the ordinary dredging-machine, and is worked by a steam-engine.

Mr. W. E. NEWTON stated that an American machine, for a similar purpose, had been used on a railway at Brentwood, and succeeded very well. It cut some millions of tons of earth away in the United States. The greatest difficulty they met with, was getting the wagons up to, and away from, the machine.

Mr. PRIDEAUX stated that two wagons could be brought up at one time, and there would be no difficulty in changing them as fast as the machine could fill them.

REVIEWS.

Practical Observations on the Present State of the Steam Engine. By G. V. GUSTAFSSON, late engineer R.N. London: George Herbert.

Mr. Gustafsson's work is a small pamphlet of 36 pages—the purport of it seems to be to show that much power is lost in the present existing forms of marine steam engines; as a substitute for which the author proposes an improvement, or rather modification, of his own. The most valuable part of his treatise is a table of the rates of motion of the steamer Acheron, and of the angular velocity and extent of immersion of her paddle-wheels—the result of experiments instituted during the three years that Mr. Gustafsson was her acting engineer. This alone, as furnishing very useful and important data for subsequent investigations, we consider a sufficient recommendation of the work to the notice of our practical readers; although we must at the same time caution them against adopting the author's mechanical views—which, in statement at least, if not in conception, appear to us extremely confused. The reasons assigned for the frequent occurrence of breakage in the various parts of marine engines, exhibit the too common incorrectness of thought concerning pressure and impact which is constantly displayed by men not thoroughly versed in the principles of mechanics. The casualties above alluded to are easily explained, and are not at all owing to any peculiar mode of construction in the engines. Marine engines are especially subject to impulsive strains, the amount of which is not easy to calculate before hand; they have no relation whatever to the horse power, or any thing of the kind, but are chiefly caused by heavy seas breaking

against the vessel—and above all, against the paddle wheels. The ordinary strains of tension are, besides, continually varying; and these causes combined continually tend to loosen and weaken the several parts of the machinery, and ultimately to produce disrupture. The evident and only way to lessen the probability of such accidents is to make the parts most liable to strains as massive as possible, and to avoid all unnecessary gearing. But the most serious objection which the author urges against the present forms of marine engines is the alleged enormous absorption of power by them, and consequent loss of useful effect. The method he adopts to estimate this loss is confessedly merely an approximation—and, as we hope presently to show, an approximation which, being based on unsound principles, is altogether wide of the truth. The resistance of water to a moving surface having previously been determined by experiment for a given velocity—and resistance being assumed to vary as the square of the velocity—it is clear that if we know the rate of the vessel's motion, and also the rate of motion and the diameter of the paddle wheels, and the depth to which they are immersed, we can calculate the "work done" during a given time. As the subject is one of considerable importance to engineers, we shall proceed to investigate formulæ for the amount of work done, and useful effect produced by the rotation of a single paddle board. We shall suppose the paddle boards rectangular and perpendicular to the edge of the wheel, so as to radiate from its centre. Let $2\alpha = \angle$ of the wheel immersed; $\omega =$ angular velocity of the wheel; $h =$ length, $b =$ breadth, of paddle boards. Let $f =$ resistance against an unit of surface for a velocity 1; $v =$ velocity of vessel; $\theta =$ angle passed over from the vertical by the given board at time t. Then the resistance against a thin slip of the board, at distance r from the centre, will be $bf(\omega r - v\cos\theta)^2\,\delta r$; and the work done while it passes through a very small angle $\delta\theta$ will be $bf(\omega r - v\cos\theta)^2 r\,\delta\theta\,\delta r$; also the useful effect—that is, the portion of the work done that propels the vessel forwards, will be $bf(\omega r - v\cos\theta)^2 r\cos\theta\,\delta r\,\delta\theta$. Therefore, integrating between proper limits, the total work done by one paddle board for one revolution of the wheel is

$$bf\left\{\frac{2\alpha\omega^2}{4}\{(l+h)^4 - l^4\} - \frac{4\omega}{3}\cdot\sin\alpha\cdot v\{(l+h)^3 - l^3\} + v^2\left\{\alpha + \frac{\sin 2\alpha}{2}\right\}\left\{\frac{(l+h)^2 - l^2}{2}\right\}\right\};$$

and the useful effect—

$$bf\left\{\frac{2}{4}\{\omega^2\sin\alpha\,\{(l+h)^4 - l^4\} - \frac{2\omega}{3}\cdot v\alpha\,\{(l+h)^3 - l^3\} - \frac{\omega v}{3}\sin 2\alpha\{(l+h)^3 - l^3\} + (2v^2\sin\alpha - \frac{2v^2}{3}(\sin\alpha)^3\frac{l+h)^2 - l^2}{2}\right\}.$$

If h be very small compared with l, these expressions become

$$bflh\left\{2\alpha\omega^2 l^2 - 4\omega l\sin\alpha\cdot v + v^2(\alpha + \tfrac{1}{2}\sin 2\alpha\right\};$$

and $$bflh\left\{2\omega^2 l^2\sin\alpha - 2l\omega v\alpha - l\omega v\sin 2\alpha + 2v^2\sin\alpha - \frac{2v^2}{3}(\sin\alpha)^3\right\}$$

The expression, which Mr. Gustafsson obtains by an empirical and not very intelligible method, is equivalent to—

$bfh(l + \frac{2h}{3}\{\left\{l + \frac{2h}{3}\right\}\omega - v\frac{\sin\alpha}{\alpha}\right\}^2 \times 2\alpha$ for the work done.

When h is small, this becomes $blfh(l\omega - v\frac{\sin\alpha}{\alpha}\right\}^2 \times 2\alpha$.

This subtracted from the correct formula, gives

$bflh\,v^2(\alpha + \frac{\sin 2\alpha}{2} - 2\frac{\sin^2\alpha}{\alpha}\right\}$; which deficiency will account for, at least, some of the power Mr. Gustafsson asserts to be lost in marine engines.

If $\alpha = \frac{\pi}{2}$ the above difference $= blfhv^2\{\frac{\pi}{2} - \frac{4}{\pi} = blfhv^2 \times 3$ nearly; a large quantity, when we consider that in most of the experiments on board the Acheron $l\omega - v.\ \frac{\sin\alpha}{\alpha}$ would, probably, for $\alpha = \frac{\pi}{2}$, be less than $\frac{v}{2}$, and therefore, the result obtained less than half what it ought to be.

Some credit, however, is due to the author for his ingenuity and perseverance in availing himself of the means of experiment within his power. That more power is expended than useful effect obtained in sea engines, no doubt is true—but the loss is not so much in the machinery itself, as in the mode of propulsion. If the floats be radial, the paddle wheels deeply immersed, and the velocity of the boat nearly equal to the relative linear velocity of the floats,—the resistance against the floats will be most powerful when their useful effect is least, and the greater part of the power will be lost. To remedy this, has been the subject of frequent patents;—various contrivances have been proposed to cause the floats to enter the water always vertically, and to preserve as much as possible their vertical position when in the water. But we believe the complexity of the machinery necessary to effect this kind of action, has hitherto been a bar to its adoption. As to the merits of Mr. Gustafsson's proposed form of an oscillating engine—and his new method of feeding the furnace—we leave our practical readers to judge for themselves—we having already overstepped the limits we had assigned to the present review.

A short Treatise on the Steam Engine. By JAMES HANN, A.I.C.E., Mathematical Master of King's College School. London: John Weale, 1847. Part I., 8vo., pp. 102.

Mr. Hann's mathematical abilities are so well known, that his name alone is sufficient recommendation to any work he may publish. He has evidently presumed that his readers are sufficiently well acquainted with mechanical principles, and especially with the theory of the steam engine, to render superfluous any explanation of technical terms connected with those subjects. In fact, the work before us is rather a class-book of reference than an elementary treatise—and as such in a compendious form, comprises nearly all the facts that can be arrived at by purely mathematical investigation, with reference to the application of steam power.

We wish, however, that Mr. Hann had been more rigid in his demonstrations, and had based them more directly on the dynamical equations of motion; for instance, in finding the relation between the pressure of the steam admitted, the load, the length of the stroke, and part of the stroke when the steam is cut off—he assumes "the work of the steam must be equal to the work done upon the load," and apparently as though it were axiomatic, instead of being a proposition capable of a proof, which is very short, and as follows:—

Let X be the pressure of the steam when the load and piston has been raised through a space x; let $m =$ mass of load and piston; v the velocity of piston; L the load;—then $mv\,dv = X\,dx - L\,dx$:

$$\therefore \frac{mv^2}{2} + c = \int X\,dx - \int L\,dx.$$

Let $l =$ length of stroke; then, when

$x = o$, and $x = l$, $v = o$.

$$\therefore o = \int_e^{o} X\,dx - \int_e^{o} L\,dx;$$

$$\therefore o = \int_e^{o} X\,dx - Ll;$$

but $\int_e^{o} X\,dx$ is the work of the steam, and Ll is the work done on the load: $\therefore$ the work of the steam is equal to the work done on the load. The way in which Mr. Hann has stated this relation, would lead one to suppose that it were true for any portion of the stroke—which is not the case. Again, in finding the velocity v, which we have obtained above, Mr. Hann most unnecessarily makes it depend on *vis viva* and work done—using, not only in this instance, but throughout the course of his book, the former of these two terms as though it implied something more than a merely analytical expression—as though, in fact, it were some independent property of force—"living force," in short, as he translates it. The term *vis viva*, as used by modern mathematicians, is a purely arbitrary and conventional expression for certain algebraical symbols. The old philosophers, however, used it to express some confused or mistaken notion respecting inherent properties of matter. It seems injudicious (to say the least of it) to revive, by translation of the phrase, exploded ideas which were only excusable in an immature state of science.

"*On the Work done by the Engine on the Piston per minute.*

"Let E represent number of cubic feet of water converted into steam pe minute, A the area of the piston in square feet, $l =$ actual length of stroke $a =$ that part of stroke before the steam is cut off, P = pressure in th boiler, $p_1 =$ pressure in the cylinder before expansion, $p =$ pressure at the x^{th} foot of the stroke, $c =$ total clearance, N = number of single strokes per minute, $V_1 =$ work of steam on piston per minute.